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The special expansion joint and gas cutoff used between the thin partitions and the end walls of the Imhoff tanks, shown in section in Fig. 1, was very successful. This varies somewhat from the original design described in the article previously mentioned. This form of joint was designed to anchor the metal lath to the end walls during construction. A groove was built in the end walls along the line of the partition and in the center of this groove wrought-iron rods with flattened ends were embedded at intervals in the concrete. Short pieces of $\frac{3}{4}$x$\frac{3}{4}$-in. steel angles were fastened to the edges of the rib-trus plates opposite each rod, to serve as lugs for anchoring the sheet-metal reinforcement. Tension was applied to the sheets by driving a taper pin or wedge into the hole in the flattened end of the rod, which caused the washers and pipe spacers to be wedged over against the steel angle lug fastened to the sheets. After the cement mortar in the thin walls had set, the pins were pulled out, leaving the partition walls free to contract without cracking. In nearly every instance these joints have opened up and but few cracks occurred in the thin walls themselves. The thin walls are 90 ft. long, with permanent supports every 10 ft.

The same type of thin-wall construction was used for the outside walls in the sprinkling filters (see Figs. 2 and 3), and the results are very satisfactory. It was specified that the surface of the wall should be left rough and no trowel finish applied. This was done with the idea that sewage running down over the rough face of the wall would be purified to a greater extent than if the wall surface was smooth. The earth backfilling on one side and the broken-stone filtering material on the other were placed at about the same time, and were carried up evenly on each side to prevent excessive pressures on the thin wall. The wall serves to keep sand and gravel from being washed into the broken stone, and with the earth backing acts as a retaining wall for the stone. For the conditions at Fitchburg, where the filters were constructed largely in excavation, this form of wall proved to be more economical than any other form considered. A concrete curb 12 in. wide and 14 in. deep was cast on the exposed edge of the thin wall to add a finish and make it more durable. The total cost of the sprinkling-filter wall, exclusive of earth backing, was approximately $3 per lin.ft., which for a height of 10 to 11 ft. is very low. The earth backing came from the filter excavation and cost practically nothing in addition, as embankment, to what it would have cost with the remainder of the excavation, which had to be placed in spoil banks some distance away. The cement-gun proved very advantageous to the contractor in this work on account of the extent of the plane surface to be plastered.

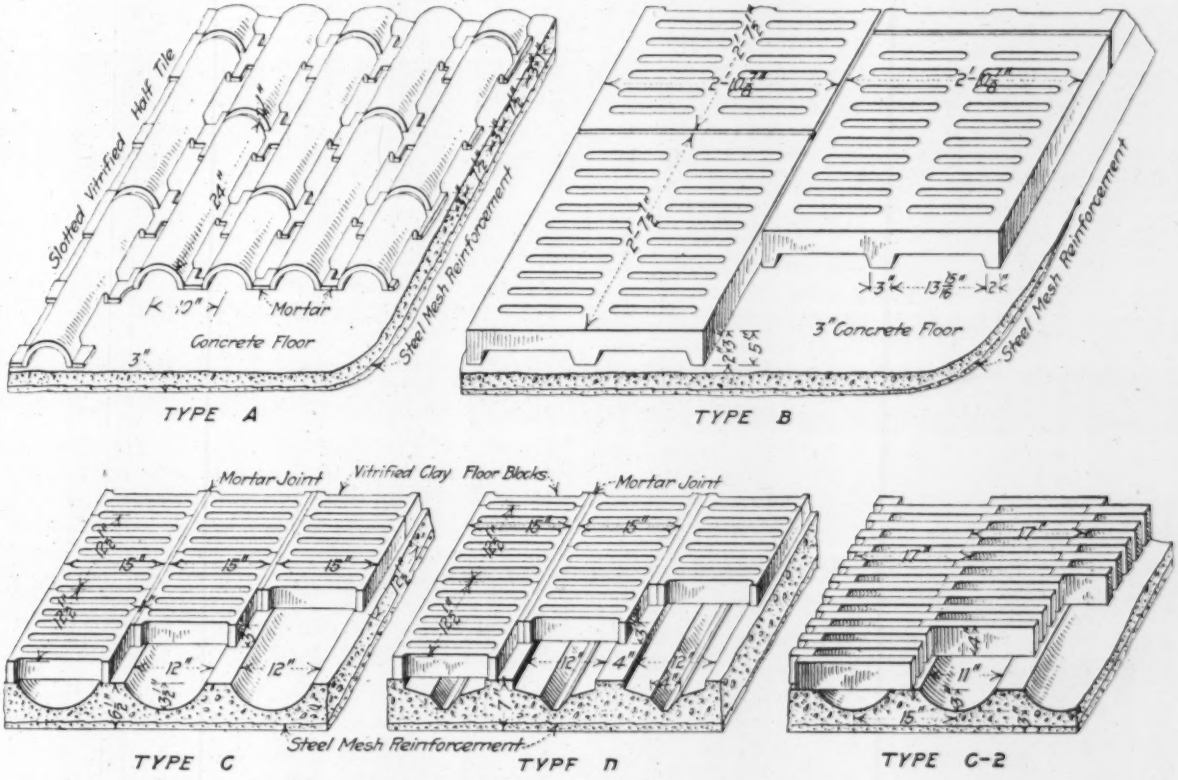


FIG. 4. TYPES OF SPRINKLING-FILTER FLOOR SYSTEM

(Bids were received on Types A to C. Type C was chosen, but, for reasons stated in the text, Type C-2 was used)

When bids were received for the construction of the sewage-treatment works four types of sprinkling-filter floor system were submitted to the contractors. These are illustrated in Fig. 4. The prices per square yard complete quoted by the R. H. Newell Co. and N. S. Brock, to whom the contract was awarded, were as follows: Type A, $2.90; Type B, $3.20; Type C, $2.60; Type D, $3.20.

Type C was selected as being the cheapest and at the same time one of the most desirable. Before constructing the floor the contractors encountered a serious difficulty on account of the failure of a clay-goods concern to furnish the vitrified clay blocks required at the original price quoted, and accordingly a new design was brought out, which was substituted for Type C. This design (Fig. 4),

Type C-2, is similar to one of the alternate designs made by Metcalf & Eddy for Gloversville, N. Y. The small cement blocks, 17 in. long by 1⅛ in. thick and about 3¾ in. high, were constructed of cement mortar composed of 1 part cement and 2 parts granite dust, mixed to the consistency of thick cream and poured by hand in gang molds and then stored in tanks under water for about 24 days. The blocks were set in place (Figs. 4 and 5) in a thin bed of mortar. With this type of floor system 43% of the floor surface is drainage area. The flat floor offers a good surface for construction purposes, and the flow is confined in good channels, which can be readily flushed and cleaned.

The filter excavation was largely in coarse sand and gravel containing many small cobbles 2 to 3 in. in diameter. A layer of these was placed on top of the small concrete floor-beams to act as a guard against "splinters" of stone dropping down between the beams or into the floor channels. The same difficulty, although to a much less extent, was experienced with the remainder of the stone, which was trap rock brought in on cars. Especially in damp weather, fine dust adhered to the stone in spite of careful screening.

The broken stone for the filters was intended to be of such size as to be retained on a 1-in. ring and pass through a 2-in. ring. Some difficulty was experienced in keeping the size of stone within these limits. Apparently a sieve having 1-in. holes and operated carefully will retain some pieces of stone as small as ½ in. in maximum dimension, and similarly a sieve having 2-in. holes will not pass all of the stone having a maximum dimension less than 2 in. It would appear desirable to use screens having holes slightly larger than the ring sizes specified. About half of the stone used was a local granite obtained from Rollstone Hill.

Four 4-ton gasoline auto trucks were used to haul the stone a distance of about three miles from the quarry to the work. Although the roads were fairly good, the stone was shaken up considerably, resulting in grinding

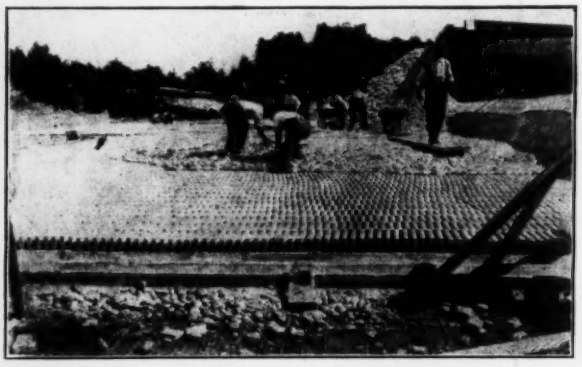


FIG. 5. CONSTRUCTING FLOOR SYSTEM AND PLACING COBBLES, SPRINKLING-FILTER FLOOR SYSTEM

and breaking, and it was found necessary to screen the stone again at the filter site to remove fine material thus produced as well as that escaping from the main screening plant. It is believed that better results would have been obtained if the stone had been both screened and thoroughly washed.

The distribution mains in the sprinkling filters, comprising 17 lines of 16- and 12-in. cast-iron bell-and-spigot pipe jointed with lead joints, were laid just below the surface of the stone, in order that the nozzles might be screwed directly into tapped holes in the mains and thereby obviate the necessity of using riser pipes. A special drilling machine was used for drilling and tapping these holes. The machine was fastened to the pipe by a chain passing around the pipe. The spindle carrying the drill and tap was set plumb by means of a machinist's

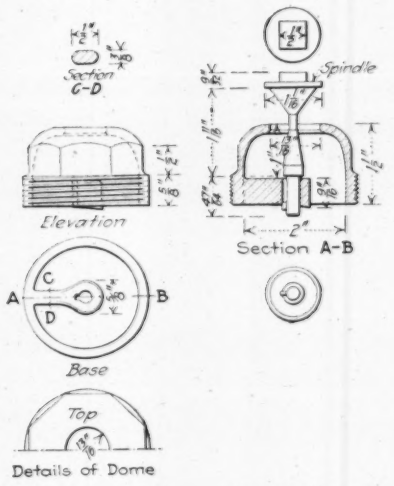


FIG. 6. DETAILS OF SPRINKLING-FILTER NOZZLE

level held against the vertical guide on which the spindle moved, and metal shims were used to adjust the machine to the required position.

The sprinkling filter nozzles used are a modified form of the nozzle developed at the Worcester sewage-treatment works. The general details of this nozzle are shown in Fig. 6. The patent rights in the nozzle are controlled by Matthew Gault, Superintendent of Sewers, Worcester, Mass.

The sewage-treatment works have been constructed under the supervision of David A. Hartwell, Chief Engineer, and Harrison P. Eddy, Consulting Engineer. The contractors were the R. H. Newell Co. and N. S. Brock. The Resident Engineer was Ernest E. Lothrop, to whom the writer is indebted for suggestions and photographs.

Philadelphia Street Cleaning by Contract

Philadelphia is one of the few large American cities where practically all the street-cleaning work is done by contract. To get this done efficiently by short-term agreements has required much study and many experiments on the part of William H. Connell, Chief of the Bureau of Highways; and the results are incorporated in the specifications for the current year, which contain many points worth noting. Abstracts of some of the more interesting clauses and those of value to city officials facing the same problem follow.

The contractor is not allowed to sublet his contract. He assumes responsibility for the use of patented materials or processes. He is liable for all damage done by his employees' acts. He is bound to observe all the city and state public health laws. City officials cannot be interested in the contracts.

Use of City Water

Water from the city low-pressure fire hydrants which have been specially marked for street-cleaning work, and generally are not less than one to a block, are used without charge only on permit issued by the Bureau of Water, and only for the purpose of executing the work designated in the specifications, the contractor being liable for any damage done to the hydrants by his employees. Failure to use a standard key in operating the hydrants, the use of leaking hose or hydrant connections, wasting the water, using unmarked hydrants, or other abuse of the privilege may result in the revocation of the permit. The city may revoke the permit when circumstances call for restriction in the use of water.

Annual Inspection

The specifications require that an annual inspection in the form of a parade shall be held during the year at a time designated by the Chief of the Bureau of Highways. The contractor is required to have his entire equipment and employees present, and any equipment or men absent from the inspection, or equipment or men present who do not conform to the requirements of the specifications, are subject to the deductions enumerated in the specifications. On the day of the inspection the men and equipment are relieved of their duties only for the time absolutely necessary, and on the completion of the inspection must continue their work for the full remainder of the day.

Reports by Contractor

The contractor makes daily reports to the Chief of the Bureau on approved forms, which indicate the number of men, machines and vehicles employed, the number of loads of dirt removed, the net weights of each, the number of sewer inlets cleaned each day and such other information as may be requested. The contractor also furnishes, in writing, such information in reference to the conduct of the work under his contract as may be required from time to time by the Chief of the Bureau of Highways. If such information is not supplied within two weeks from date of request for the same, the city may retain such payment as may be due the contractor until he has supplied the information requested.

The contract may be annulled at any time for failure to commence work when specified or to prosecute work to the satisfaction of the city officials. Failure to comply with any part of the specifications is cause for the city, after giving 24-hr. notice to the contractor, to employ sufficient force to have the work properly done and to pay for the same out of the fund deposited by the contractor as security. Payments are made monthly.

Qualifications of Employees

All employees must be thoroughly able-bodied and capable, both physically and mentally, of performing their duties to the satisfaction of the Chief of the Bureau of Highways. Any employee showing evidence of physical or mental incapacity is to be discharged upon the demand of the Chief of the Bureau, and is not to be re-employed except with the written consent of the Chief of the Bureau. All employees must be able to speak English satisfactorily. None but citizens of the United States are employed.

Any employee who neglects his duties, or uses improper language, or is under the influence of liquor while on duty, or accepts or demands pay from citizens for service rendered, or falsifies any report he may be called upon to make, is, upon demand of the Chief of the Bureau of Highways, to be at once discharged.

Each inspector, superintendent or foreman is required to wear while on duty a dark-gray uniform. All other employees must be provided at all times with uniforms approved by the Bureau of Highways. Uniforms are to be kept clean and must not be worn longer than one week without washing. Each employee must also wear at all times a badge on his hat or cap having thereon "D. P. W." in large letters and "Bureau of Highways" in small letters, also the number of the street-cleaning district, preceded by "Dist.," and a serial number. Each employee must also be provided with a suit of oilskin and other necessary articles to protect him while working during inclement weather.

Equipment

All sprinklers, cleaning machines, carts, wagons and other vehicles used in the prosecution of the work under the specifications must be painted in colors designated by the Chief of the Bureau of Highways, and all repainting during the life of the contract must be done in the same colors. All equipment is to be painted at least twice during the year with standard paints, specifications for which are on file in the office of the Bureau of Highways, and must be painted more frequently if these two paintings do not preserve the permanency of the distinguishing colors. The equipment must at all times be maintained in a cleanly condition, and the contractor is required to install adequate cleaning facilities within his stable or yard. Cleaning equipment in streets is not permitted.

Each kind of equipment is defined and described in detail, including squeegees, flushers, machine brooms, sprinklers, hand machine brooms and hand brooms. The contractor is required to keep all his equipment in repair and adjustment, subject to city inspection.

Classification of Street Cleaning

The city is divided into eight districts, and the kind and amount of street cleaning to be done in each are defined. A table is included in the contract giving the areas in each district to be cleaned every day, every two days, every three days and once a week. The day working hours are 7 a.m. to 12 m. and 1 p.m. to 6 p.m., and the night hours, 7:30 p.m. to 6 a.m. The work includes cleaning sidewalks of all waste paper and other refuse and in winter snow removal from the streets.

Liquidated Damages

The amounts of liquidated damages for each kind of neglect, or failure to comply with the specifications, are parts of the contract. There are 38 of these sums specified for various infringements of the contract specifications, and these vary from $25 a day for neglect to make daily reports to 50c. a day for failure of employees to wear badges and the prescribed uniform in a cleanly condition. For instance, failure to provide machine brooms with dust guards entails a loss to the contractor of $1 a day for each machine so operated. For cleaning streets without sprinkling (unless so authorized) $1 per square or part of square so cleaned is charged against the contractor. For not properly loading street dirt into wagons or carts or spilling the dirt 50c. is charged for each offense. These are random illustrations.

Two Large Irrigation Projects in Russia

By Milan Nikolitch*, Assoc. M. Am. Soc. C. E.

SYNOPSIS—Immense areas of dry land are being brought under irrigation by the Russian Government. Of two projects to be described, that on the Golodnaya Steppe, in Turkestan, reclaims for the present some 125,000 acres, while the one on the Mugan Steppe, which borders the Caspian Sea, reclaims 465,000 acres. The Golodnaya Project, here described, is a relatively simple one, consisting of head-gates, 32.6 miles of main canals, 110 miles of distributary and main-drainage canals and 780 miles of laterals and secondary-drainage canals. The Mugan Steppe Project, which will be described in a later issue, is more complex, comprising four independent canal systems.

Within the limits of the Russian Empire, stretching from the 17th to the 191st meridian and from the 35th to the 78th parallel, there is a great variety of climates. Speaking broadly, the average yearly rainfall varies between 16 and 28 in., with the exception of the western provinces of European Russia, where the rainfall rises above, and Caucasia and Turkestan, where it drops below that figure.

The greater part of southwestern European Russia belongs to the zone where agriculture is partly dependent upon irrigation. Turkestan and the eastern part of Transcaucasia are representatives of arid lands in the true sense of the word and require complete irrigation for existence.

It is very probable that in old times a certain portion of now desert lands in Turkestan and Caucasia were irrigated, but there are no means of judging of their magnitude. The most prosperous provinces of Turkestan, like Samarkand, Tashkent and Fergana, have been irrigated from time immemorial and are still supplied with water by primitive native canals. The water-supply for irrigation in Turkestan is mostly derived from small mountain rivers at their emergence upon the plains. Although the small rivers are almost used up, the large ones are scarcely touched.

It is certain that there is more land in Turkestan than can be supplied with water. The six great rivers of Turkestan and Transcaucasia—Illi, Choo, Sir-Daria, Amu-Daria, Arrax and Kura—have a total annual runoff of about 93,000,000 acre-ft., which can all be used for irrigation. Altogether the water-supply of Turkestan is sufficient for many millions of acres.

With the exception of native works, the art of irrigation is quite new in Russia and almost entirely confined to government enterprises. It might be safely said that there is not a single private enterprise of importance. The first large irrigation project in Russia was the irrigation of the Imperial Domains on the Murgab River, described in Engineering News, of Apr. 4, 1912.

The two irrigation projects here described are, so to say, pioneer projects and do in no way represent the standard work of the Russian Reclamation Service. They were begun with small means, and could be seriously attended to only in the last two or three years. The systematic work of the Reclamation Service was begun only a few years ago, but it has already developed to great proportions, promising to give excellent results. At the head of the Reclamation Service are Prince V. Masalsky and S. P. Maximoff, M. Am. Soc. C. E.

What is known as the Golodnaya Steppe occupies the country inclosed between the Sir-Daria River, the Turkestan Mountain range and the Kizil Kum Desert. It is situated between the 40th and 41st parallels and has an average altitude of 927 ft. above sea level. The total area of this country is about 1,900,000 acres, but not all of it can be irrigated. With the completion of the northeastern Golodnaya Steppe irrigation project, about 218,700 acres will be reclaimed. Surveys and designs for the other portions of the steppe are under way, and in the near future a great portion of the former arid waste will be brought under irrigation. The situation of the Golodnaya Steppe between the rich provinces of Tashkent, Samarkand and Fergana, with which it is tied by railroad lines, together with rich soil and favorable climatic conditions, guarantees the success of the enterprise.

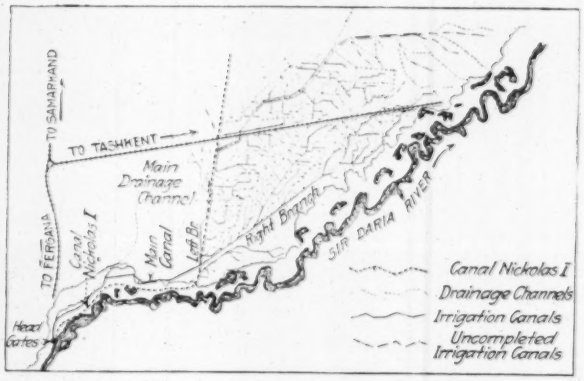


Fig. 1. Map of Golodnaya Steppe Irrigation Project, Russia

The climate of the Golodnaya Steppe is continental and is characterized by extremes. The summers are long and hot; the winters are sometimes very cold. The temperature reaches as high as 108° F. in the shade and as low as —20° F. The maximum mean monthly temperature for a period of seven years was 83° F., while the minimum was 19.2° F. Low temperatures last but a short time. The summer heat, on the contrary, extends over a long period of the year. An average for seven years shows that the number of days without frost in the Golodnaya Steppe is 209.

The precipitation is comparatively small, and the greatest portion of it occurs in the winter. The average rainfall for five years was 12.3 in., but for a longer period of observation it would probably be less. Of this

*Chief Engineer, Northern Semiretchensk Irrigation Project, Verny, Turkestan, Russia.

amount only 0.55 in. fell during June, July, August and September.

The low rainfall, the great dryness of the air and the fact that the dry period of the year coincides with high temperatures make irrigation a necessity. For only a short time during the early spring the steppe is covered with luxuriant vegetation, but in May the sun and the lack of moisture turn it into a desert-like area, fully justifying its name, the Steppe of Hunger.

The water-supply for the Golodnaya Steppe is diverted from the Sir-Daria River, the only stream which can insure a supply to a large area. Sir-Daria rises in the mountains of the Central Tian-shan, where its two branches are known as Narin and Kara-Daria. Both are torrential in character in their upper courses. After leaving the mountains, each river runs through the province of Fergana, where a great portion of the Kara-Daria is used for irrigation by the native works. The Sir-Daria, made up by the junction of the Narin and the Kara-Daria, flows for some distance through Fergana, and after passing the mountain Mogol Tau, enters the great central Asiatic plain, through which it runs for about 810 miles to the Aral Sea. The total length of the river is about 1430 miles.

The Sir-Daria owes its waters to the melting of snow in the high mountains. Its high-water period occurs in summer, when mostly needed for irrigation.

The discharge of the river has been regularly observed since 1903. In the following table are given mean annual discharges of the Sir-Daria for a period of eight years, according to the reports of the Turkestan hydrometric service:

ANNUAL DISCHARGES OF SIR-DARIA RIVER FROM 1903 TO 1910

(Gaged at the head of the main canal)

Year	Discharge, Sec.-Ft.	Year	Discharge, Sec.-Ft.
1903	27,000	1907	22,400
1904	22,400	1908	33,500
1905	22,500	1909	22,400
1906	17,100	1910	23,000

The maximum discharge occurs in May and June and the minimum in January. During the period 1903-1910 a maximum of 109,000 sec.-ft. has been observed, while during the same time the minimum was 6860 sec.-ft.

HISTORY—The art of irrigation has been practiced in Turkestan from very early times. Large areas that are now abandoned and desert-like have been reclaimed in the past. Still, the Golodnaya Steppe does not seem to have been irrigated to a large extent, although, judging by existing legends, attempts to that end were not lacking. The fact that the river lies some 50 ft. below the floor of the Golodnaya Steppe made it difficult for native engineers to bring the water to the steppe, and all attempts resulted in a few small canals, their remains still being traced in the steppe. Only the lowland along the river and the area near the mouth of cañons of the small mountain rivers were irrigated to some extent.

With the Russian occupation of the country the idea of reclaiming the Golodnaya Steppe by the water of the Sir-Daria was renewed. During the last 40 years several attempts have been made, but owing to various unfortunate circumstances, most of them proved failures. Only the Canal Emperor Nicholas I was successfully completed. It irrigates an area of about 32,400 acres.

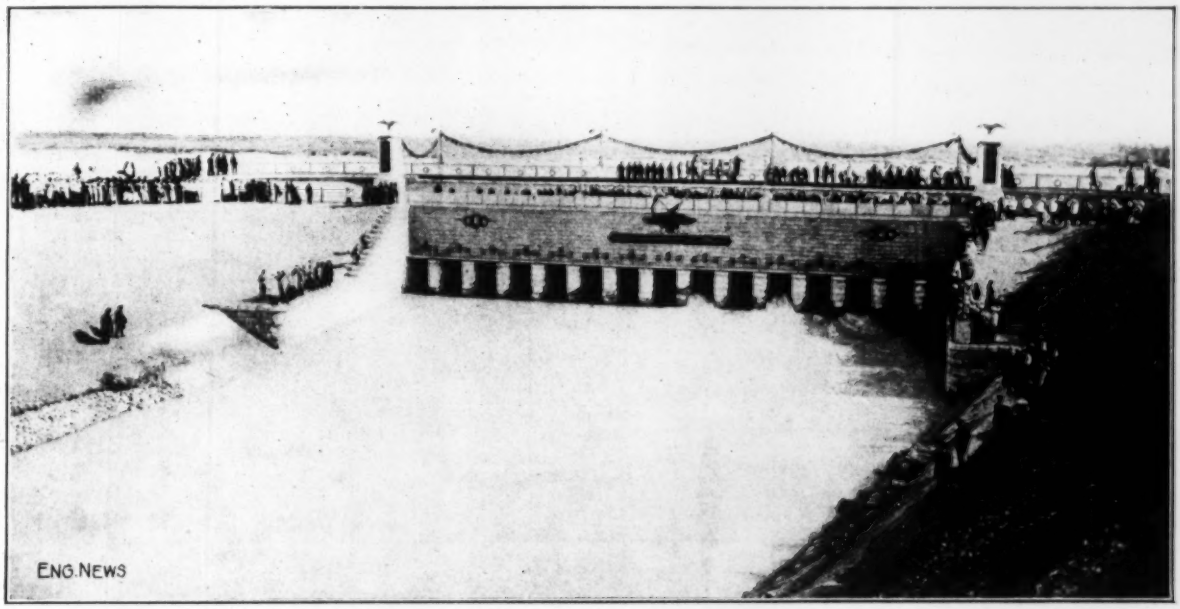


FIG. 2. VIEW OF HEAD-GATES OF GOLODNAYA IRRIGATION PROJECT

(The structure was officially opened on Oct. 5, 1913, in the presence of many state officials)

The first steps toward irrigating large areas of the Golodnaya Steppe by the government date back to 1895, when the first well-organized parties were sent there. The actual work of construction of the Northeastern Golodnaya Steppe project began in 1901, and was prosecuted slowly on account of lack of funds until 1911, when the first large appropriation was made and the work vigorously resumed. By the end of 1913 most of the work was completed. The area thus brought under cultivation is 121,500 acres, not counting 32,400 acres, dominated by the Canal Nicholas I, which is to be incorporated into this system.

GENERAL FEATURES OF THE PROJECT—Generally speaking, the project (see map, Fig. 1) comprises head-

gates, a main canal 23.6 miles long, distributaries and main drainage canals 110 miles long, laterals and secondary drainage channels about 870 miles long, regulators, outlets, bridges, etc.—altogether 540 structures.

During the construction about 17,500,000 cu.yd.of earth had to be moved, of which 46% was from the main canal. The total area covered by the canal is about 218,700 acres, but only some 125,000 acres is supposed to be actually irrigated at one time. The cost of the works is estimated to be $3,660,000, or a unit cost of $29.28 per acre of irrigated land.

Head-Works—No dam is provided, and in order to assure the full supply to the canal during the lowest water stand in the river, even when other irrigation projects along the upper course of the Sir-Daria are realized, the sill of the intake gates is placed at about the bottom elevation of the river. This has resulted in a maximum head against the gates of about 21.7 ft.

The head-gates (Fig. 2) are similar to those used on irrigation canals in India. They consist of 15 openings, 6.3x10.50 ft., separated by masonry piers 28.70 ft. high and 3.50 ft. thick. The piers rest upon a heavy concrete foundation 8.75 ft. thick, which is faced by granite blocks 1.05 to 1.75 ft. thick. The entrance to the canal is regulated by steel gates raised by a traveling winch from the working platform. A row of stop logs, placed in the front of the gates, is provided to prevent the débris, carried on the bottom of the river, from entering the canal, and to help in obtaining relatively clear water from the surface. To reduce the effect of the falling water upon the floor, provision is made for another row of stop logs in the rear part of the piers, by means of which a kind of water cushion is created. For a distance of 2450 ft. below the head-gates the bottom and the slopes of the canal are protected by rubble masonry, concrete and riprap. The cost of the structure was $288,000.

The Main Canal—The floor of the Golodnaya Steppe below the head-gates is about 56 ft. higher than the alluvial lowland along the river. The length of the main canal from the head-gates to the point where it emerges upon the steppe and is divided into two main distributaries is about 23 miles.

The first part of the canal is made in conglomerate and gravel, after which the canal runs through the lowland area, mostly in cut, also in combined cut-and-fill section. Toward the end the canal extends through several deep cuts, of which the deepest is about 53 ft.

The dimensions of the main canal have been designed according to the material in which the canal is located. The bottom width varies from 56.70 to 98 ft. The depth ranges from 5.25 to 9.45 ft. The adopted grade is rather higher than is commonly used for canals of this size, varying from 0.0001 to 0.0007. The discharging capacity of the canal is said to be not less than 1715 sec.-ft. Where the canal is made in cut it is given side slopes of 1½ : 1 and in deep cuts above the water surface ¼ : 1. Embankments are made with side slopes of 2 : 1 and have a top width of 21 ft.

The total earthwork, in amount of 8,130,000 cu.yd., cost $1,215,000. About 266,000 cu.yd. of excavation in gravel and conglomerate at the head of the canal has been done with a steam shovel. For the remaining part hand labor has been used exclusively.

The Distributary System—At the 23d mile the main canal is divided into two branches, which are practically two main canals. The Right Branch was completed early last year (May 16, 1914), while the other branch is only partly completed with a view to future extensions. The topography of the country allowed of so locating the canals as to enable them to supply the water to laterals on either side.

Figs. 3 and 4. Views on Golodnaya Steppe Irrigation Project, Russia
(Fig. 3 (left)—The Lübeck excavator. Fig. 4 (right)—A regulator at the head of a distributing canal)

The Right Branch is designed to have a capacity of 600 sec.-ft.; the Left Branch, of 1294 sec.-ft. The Right Branch has a length of 29.3 miles, besides two main laterals, while the Left Branch is 33.3 miles long. The cross-section of both branches is so designed that the water is mostly above the surface of the surrounding country. Of 3,660,000 cu.yd. moved from the canal cross-section and borrow-pits, about 2,950,000 cu.yd. were used in embankments. The top width of the embankments is from 10.50 to 17.50 ft. and the side slopes are 2 : 1. The grades vary from 0.0001 to 0.0005.

The water surface in the canal being well above the ground surface, special care was exercised to obtain tight embankments by thorough wetting and tamping. A special feature of building embankments on several canal sections was to provide, by means of low embankments, basins of the required width and to dump earth into

them and allow it to settle under water, after which the water was drained off. The embankments obtained in this way are said to be more satisfactory than those made by common methods of wetting and tamping.

So far the lateral system is built to deliver water to units of 370 acres, but as the land is to be sold in units of 8 to 10 dessetins, or about 21.60 to 27 acres, it is very probable that the government is going to construct the lateral system to suit this subdivision, leaving only the farmers' ditches to private initiative.

The lateral outlets are of concrete or reinforced concrete, controlled by steel gates. With the completion of the system there will be about 292 miles of laterals and 510 outlets.

During the construction of the distributary system both hand and machine work were used. Three excavators of the type shown by the view, Fig. 3, were installed, and gave fairly good results.

DRAINAGE SYSTEM—The small slope of the country, the proximity of ground water, the presence of alkali and the possibility of increasing it with the use of irrigation, but especially the aim to improve the alkali soil by thorough drainage, have imposed the necessity of designing and building a complete drainage system at the same time as the irrigation system.

The main drainage channel is excavated in the valley between the Right and Left Branches. It is 35.8 miles long and has a discharge of 515 sec.-ft. With a small exception the entire irrigated area drains into it. The total length of drainage canals and ditches amounts to about 537 miles. The object of the drainage system is not only to take care of the surplus water in the soil, but also of one part of the surface water, which is going to be wasted through the main collector into the river.

STRUCTURES—With the exception of the head-gates, there are no structures of special interest. (See Fig. 2 for head-gates and Fig. 4 for a minor head-gate or regulator at the head of a small canal.) For building material, concrete and reinforced concrete were used for permanent bridges, regulators and outlets. Concrete and rubble masonry were used in substructures of steel bridges under railroad tracks; common and adobe brick for buildings, and wood for temporary bridges.

FUTURE EXTENSIONS—By the project just completed, only the northeastern part of the Golodnaya Steppe is irrigated; but simultaneously with the construction other large areas of the steppe have been surveyed, and at the time of writing the designs are being prepared. In the near future there will be about 1,323,000 acres of irrigated land in this part of Turkestan. Of the total acreage it is estimated that 594,000 acres are in the northern part of Golodnaya Steppe; 648,000 acres in its southern part, and about 81,000 acres are situated on the right bank of the Sir-Daria, which is also called the Dalverzin Steppe.

For this great undertaking some change must be made in the adopted type of the head-works, which are not designed to meet the requirements of a large project. Very probably a dam will be built across the river at or above the present head-gates. By means of the dam, water can be taken direct to the floor of the Golodnaya Steppe. The drop thus created in the canal can be utilized for generating power, which again can be used for pumping.

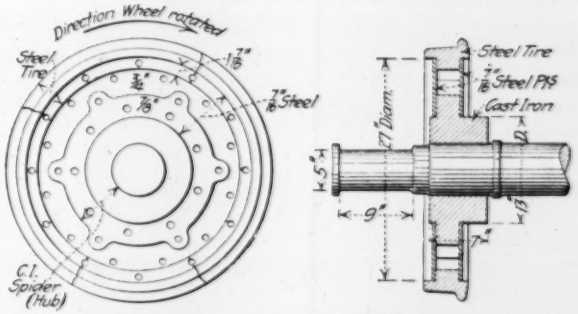
The construction of the project has been made under the chief engineer, F. Tolmacheff, and the assistant chief engineer, A. Kursish, to whom the author is indebted for many data. The contractor was S. N. Chaeff.

[*The Mugan Steppe Project will be described later.*]

Built-Up Car Wheels Declared Inadequate

Steel-railway-car wheels built up with a cast hub, rolled tire and thin cheek plates have been declared of insufficient strength for present requirements. This statement is made by H. W. Belknap, Chief of the Division of Safety, and J. E. Howard, Engineer-Physicist, Interstate Commerce Commission, as the result of investigations following the derailment of a passenger train, caused by a broken wheel, on the Chicago, Milwaukee & St. Paul Ry., at Oakwood, Wis., on Jan. 30, 1915.

After this accident the tire of the wheel causing the trouble was found broken in four pieces, three of which were recovered in 850 ft. back along the track. The remaining piece has not been found. The construction of



ELEVATION AND SECTION OF BUILT-UP WHEEL WHICH FAILED AT OAKWOOD, WIS.

the broken wheel was as shown in the accompanying sketch. Besides the four radial fractures, which all passed through bolt holes, the tire web was cracked from each bolt hole to the inner circumference. The broken pieces of tire assumed a radius of curvature slightly less than when intact, indicating internal stresses. Lack of rigidity and of unity of action in the built-up wheel were shown by brightened plate metal around the outer bolt holes and by shoulders where the inner edge of the tire web bore. The mate to the broken wheel (on the same axle) was found to have incipient cracks at each bolt hole of the tire, though otherwise intact. The total travel of the broken wheel was 276,400 mi., corresponding to 170 million revolutions. The loads ranged from 9375 to 11,250 lb.

Twenty similar wheels which had been removed (for cause) from service were examined, and half were found defective, 56 incipient cracks being seen in the interior of the webs and 19 full fractures. All the tires examined showed internal stress, due to cold rolling in service. One tire through which a radial cut, 2 in. wide, was made sprung together $1\frac{3}{8}$ in.

The presence of incipient fractures cannot be detected by hammer test or external inspection—only by partial dismantling of a wheel. The critical places in the construction are hidden by plates and bolts. While wheels of this type are reported as not being used as much as formerly, the investigators recommend inspection of the metal at bolt holes as a safety measure.

The Federal Railway-Valuation Work*

By George H. Burgess†

In the Federal valuation work now under way the Interstate Commerce Commission and the railways of this country are engaged upon an undertaking of great magnitude, and one for which there have been no well-established precedents in this or any other country.

The first state valuation of railways was made in Texas in 1894 for the regulation of security issues. This work was taken up in Michigan in 1900 and in Wisconsin in 1903 for taxation purposes, and in Minnesota in 1907 in connection with revision of rates. Valuations have also been made in Washington, New Jersey, South Dakota, Nebraska, Kansas, Oklahoma and California for various purposes.

The trend toward a Federal valuation of all railroad properties in the United States began with recommendations in the early reports of the Interstate Commerce Commission that such work be undertaken. In 1900 the Interstate Commerce Commission made an investigation of the value of all railroad properties as indicated by market prices of securities, and expanded this work in coöperation with the Census Office in 1904. President Roosevelt in March, 1906, wrote to the Interstate Commerce Commission stating that it seemed to him to be desirable to have a valuation made, and in December, 1906, and again in December, 1907, Senator La Follette introduced bills providing for such a valuation. The final bill which has resulted in this work being undertaken was approved by the President Mar. 1, 1913. There is nothing in the act which specifies the purpose for which this valuation is to be made. The results may be used for any of the following purposes: Taxation, rate-making, control of security issues and state ownership.

The provisions of the act require the ascertainment of the original cost to date, the cost of reproduction new, the amount of depreciation, and other values and elements of value. It also provides for investigation into the financial and corporate histories of the properties and a study of the amount and nature of public aid given in connection with the construction of railroads. The act provides that after the commission has made its investigation and has arrived at a determination of the value of any property, public notice of the same shall be given, and the carrier is allowed 30 days to either accept or appeal from the findings of the commission. It is this provision that makes it so necessary for the carriers to have their own organizations to follow closely the work of the commission's employees, so as to be prepared when the valuation is announced to either accept or reject it.

The Government organization for this work consists of a director of valuation assisted by an advisory board and an attorney, an engineering board, an accounting board, and a land board, as well as a number of men for special purposes; as, for instance, a cost-data bureau has recently been established to make a study as to unit prices to be applied to construction quantities. Charles A. Prouty, who was a member of the Interstate Commerce Commission at the time of the passage of the Valuation Act, is director of valuation. The country has been divided into five districts, each containing about 50,000 mi. of railroad. These districts are known as the Eastern, Southern, Central, Western, and Pacific. The engineering board consists of five members, each member having charge of one of the districts.

Each member of the engineering board is assisted by a district engineer, who is in charge of all the field organizations for his district.

All the members of the engineering board and the district engineers have had considerable experience in railroad work. Of these ten men, nine are members of the American Society of Civil Engineers. The organization for each district consists of a number of engineers having varied duties. There is an assistant district engineer, civil, structural, signal, mechanical, electrical, bridge, roadway and track, field, and office engineers, architects, inspectors of motive power and car equipment, and numerous engineers filling positions in the field parties.

Parties have been sent out on several railroads in each district to make the actual field surveys and field inventory. A field party generally consists of ten men divided into squads or groups, some of which do cross-sectioning, others chaining, and others miscellaneous field and computation work. All of the engineers employed in this work, with the exception of the members of the engineering board and the district engineers, have been selected through the Civil Service Commission at Washington. Many of the higher rated engineers have been selected by the Civil Service Commission, not by means of examination but through selection based on study of a man's record as submitted by himself and as given by references to whom he may have referred the commission in connection with his application. For the junior positions, regular written examinations have been submitted, and the result of such examination, together with a man's record as to education and experience and recommendations by his references, has established a basis for selection.

So far as the work has been undertaken by the Government in the field, it has been to make a very careful and minute survey of all physical property. This involves cross-sectioning of the entire road and careful compilation of quantities of cuts and fills and the classification of materials. All bridges and buildings are measured; all tracks and various units that go to make up the track, such as weight of rail, number of ties, frogs and switches, spikes, fastenings of all kinds, and depth and character of ballast, are noted, and proper allowance is made in compilation of quantities in connection with each item. No attempt has thus been made to establish uniform prices to apply to the units found by the field survey. This is probably a question that will require careful consideration and conference between the Government engineers and the carriers. The Government has, as before stated, established a bureau, the sole duty of which is to investigate unit costs, and this work is in the hands of men who are undoubtedly well suited to handle this question.

Survey parties were placed in the field by the Government in 1914, and work has been in progress on about 16 different lines. Field work has been practically completed on six railways, about 3800 mi. of line.

*From a paper presented before the Binghamton Engineering Society.

†Chairman of Valuation Committee, Delaware & Hudson Co., Albany, N. Y.

The Binder Course in Asphalt Pavements

By Robert Klotz*

Present-day practice in sheet-asphalt and asphaltic or bituminous pavement construction for city streets and discussions of defects in such pavements show evidence of a constantly increasing tendency to overlook the purpose and importance of what is known as the "binder course," even to the extent of entirely eliminating this course or any substitute for it.

The various schemes and devices brought forward from time to time for the purpose of eliminating the wave effect met with in pavements of this character lead to the conclusion that a gentle reminder of the nature of and reason for the binder course might be of value to those interested in the question of economical pavement maintenance.

The purpose of the binder course is, as its name implies, to bind the top layer or wearing surface of the pavement to the base, whether the latter be of concrete, granite block, macadam or other material. The mixture used for the wearing surface is designed to form, under compression, a reasonably hard, durable and impervious covering, and being therefore comparatively low in bitumen has little if any power of adhesion.

The binder course originally used consisted of graded gravel thoroughly coated with coal tar, or coal-tar pitch, and laid at a temperature sufficiently high to provide for good adhesion to the base and to the surface layer.

The coal tar or pitch was later replaced by asphalt or asphaltic cement, presumably because of the increased difficulty of obtaining tar economically, due to the development of the water-gas process for the manufacture of illuminating gas and the consequent reduction in the quantity of commercial coal tar produced, and because of the decreased cost of the asphalt and its availability as part of the stock of the mixing plant. While the adhesive power of the binder thus produced was apparently lower than that of the tar-binder, it was still sufficient to provide the binding action required to prevent the forming of waves in the surface.

Within the last three or four years the various asphalt companies have introduced, apparently with a view to economy, what is commonly referred to as a close-mixture binder, which consists of broken stone screenings, varying from about a 1-in. size downward, covered with hot liquid asphalt. Owing probably to the reduced first cost of the pavement thus obtained, the use of this type of binder has been permitted under certain specifications, and quite a considerable area of this pavement has been laid.

The writer's experience with this type of binder, particularly on repair work, has shown that the old-style, or stone, binder is far more preferable and the one to be relied on to prevent the formation of waves in the pavement surface.

Owing to the decreased viscosity of the asphalt necessary to provide for the proper mixing of close-mixture binder, the coating on the particles of stone is comparatively thin. This makes the mixture subject to cooling below the critical temperature, within the time required for delivery and laying. The weight of the roller is more evenly distributed over the surface of contact between the binder and the base, and the pressure on the individual particles of stone is insufficient to bring the hotter portion of the more or less hardened coating into intimate contact with the base.

With new pavement the unfavorable behavior of the "close mixture" is less evident than when an old pavement is repaired, due, no doubt, to the greater care and the more exacting supervision.

The action of an asphalt pavement where no binder course is used was brought very clearly to the writer's attention during 1912, when he was in charge of certain pavement repairs in the city of New York, all of the work being subject to the city's specifications and inspection.

During the early part of that year an order was issued to the effect that when repairs were required on asphalt pavements where the thickness of the original pavement, consisting of 1 in. of binder and a 2 in. top course, had been reduced to 1½ in. or less (that being the newly specified thickness of the top course), the binder course was to be omitted.

The writer managed to avoid almost entirely the forming of waves in the pavement, which he felt certain would be the result of literal adherence to this order, by having the base spattered or painted with a coating of hot liquid asphalt immediately before laying the top-course mixture, this asphalt acting as a very efficient "glue." Repairs made under the direct supervision of the city authorities on the same streets and subject to the same traffic, without the thin but effective layer of adhesive, showed waves within from two to three days after laying, and were destroyed by the action of traffic within two or three weeks.

While various theories have been advanced from time to time to account for the waves formed in asphalt pavements, some of them apparently based upon sound reasoning, practical experience seems to show that whatever may be the particular action of traffic which causes them, waves can be avoided by providing a proper bond between the pavement proper and the base, and that three-wheel rollers, etc., are unnecessary and inadvisable complications to attempt to insert into the science of constructing and maintaining bituminous pavements.

An example of the need of special care in the construction of the binder course is shown in some work carried out by the writer in New York City in 1910, the area involving about 250 sq.yd. of sheet-asphalt pavement located in and around two underground-conduit car tracks with a double branch-off and curves, both being crossed constantly in the same direction by exceedingly heavy traffic. Frequent repairs had been required at this point owing to the rolling effect of traffic, the asphalt being continually forced against the rails and ground off as it reached the level of the head.

The relaying of the entire area was required upon the reconstruction of the tracks, and the work was carried out during the night and the early morning to permit laying of the pavement without seriously hindering traffic. Under the circumstances, the supervision of the city authorities was not as definite and exacting as might have been the case had the work been done during regular hours; and as the sub-base was known to be of a sufficiently dry and porous nature to permit of the proper setting of the base, the asphalt was laid on the "green" concrete, which had been in place from 3 to 12 hr.

*111 West 49th St., New York City.

This pavement remained in place for over 2½ years under the same traffic conditions as previously, the only repair required being one small patch where the asphalt had been disturbed by a loose rail joint.

Sad to relate, this area was almost entirely removed in connection with subway construction at the end of the time mentioned. A more extended record of its behavior would probably have been of considerable value, although the writer feels that the performance up to the time of removal was sufficiently marked to warrant more consideration of a proper joining of the pavement and the base than seems to be the practice at present.

Constructing the Fitchburg Sewage-Works

By Frank A. Marston*

SYNOPSIS—Features of the work were the 2½-in. cement-plaster and metal-lath walls of the Imhoff tanks and sprinkling filters, and the drainage system of the sprinkling filters. The sprinkling nozzles are also described.

Operation of the sewage-treatment works for the city of Fitchburg, Mass., was officially started on Oct. 8, 1914, and put into full swing a week later. The design of these works, consisting of Imhoff settling tanks, sludge beds 10 ft. deep, sprinkling filters and secondary settling tanks, was described in Engineering News, June 5, 1913, page 1176. As a number of the details are unusual, it may be of interest to consider them in view of the knowledge gained during construction.

The thin partition walls in the Imhoff tanks were constructed of 1½- to 2-in. cement plaster on rib-metal reinforcing lath of the type known as rib-trus, manufactured by the Berger Manufacturing Co., Canton, Ohio. The sheets of steel were supported every 10 ft. by structural-steel frames, and temporary wooden supports were also provided to reduce the unsupported span to 5 ft. during construction. Even with these additional supports considerable difficulty was experienced in keeping the partitions in proper alignment. The cement mortar, composed of 1 part cement and 2 parts granite dust, was applied by means of the cement-gun. This method, although producing a dense, hard wall, increased the difficulty in screeding and troweling the surface to requisite smoothness. The upper edge was made square by shooting the mortar against a piece of lagging laid along the top of the steel sheets. The chief difficulty in manipulating the cement-gun was to secure a uniform thickness of wall and uniform width of slots at the bottom of the V-shaped troughs. The cement mortar, as shot from the nozzle, accumulated rapidly on the steel, both on the ribs and flat surfaces, so that it was difficult to obtain a wall having a plane surface. This latter effect was produced by screeding and troweling. It is a question whether hand-plastered work would have been as cheap or as durable; on the other hand, it would have been possible to obtain a better-finished surface. The lower edges could probably have been handled more easily if a light steel angle had been fastened to the edge of the steel sheets as a stiffener.

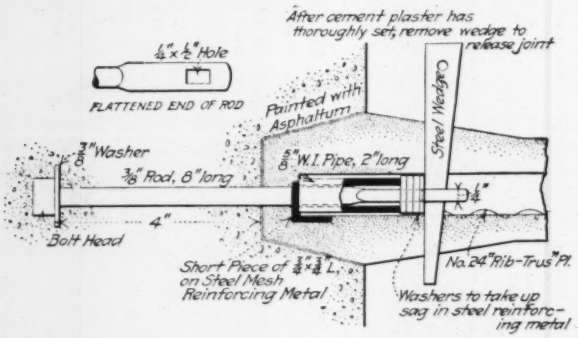

After cement plaster has thoroughly set, remove wedge to release joint
¼"x½" Hole
FLATTENED END OF ROD
Pointed with Asphaltum
Steel Wedge
⅜" Washer
⅜" Rod, 8" long
6" W.I. Pipe, 2" long
¼"
4"
Bolt Head
Short Piece of ¾"x¾" L. on Steel Mesh Reinforcing Metal
No. 24 "Rib-Trus" Pl.
Washers to take up sag in steel reinforcing metal

Fig. 1. Expansion Joint between Trough and Walls of Imhoff Tank

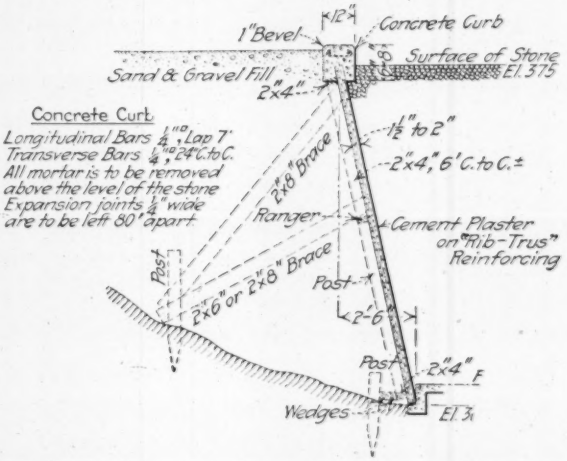


Fig. 2. Details of Retaining Wall for Sprinkling Filter

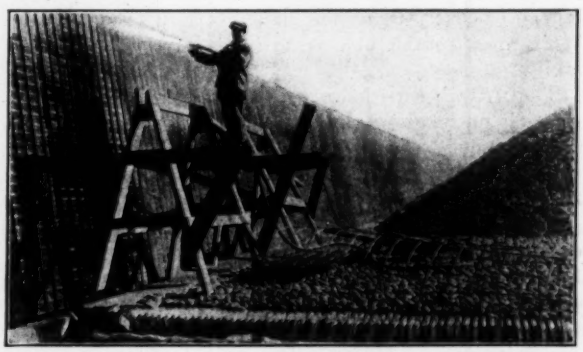


Fig. 3. Applying Cement Plaster to Wall of Sprinkling Filter

*Assistant Engineer with Metcalf & Eddy, Consulting Engineers, 14 Beacon St., Boston, Mass.

Cost of the Work

When it was first suggested that a valuation should be undertaken of all the railroads in the United States, Professor Adams, statistician of the Interstate Commerce Commission, stated his belief that the work could be done at about the same cost as the work that was completed in Michigan at about that time, about $5 per mile or $1,250,000 for the whole country, and that the cost to the railroads would probably be as much more. The costs of all state appraisals had been not to exceed $10 per mile, and in Texas as low as $2 per mile, indicating a very incomplete method of doing the work. In 1912 Interstate Commerce Commissioner Clements stated that the cost would probably approximate $3,000,000 and the length of time to do the work would be three years, although he afterward stated that the cost might run up to $5,000,000 and the time to five years. Interstate Commerce Commissioner Meyer at about the same time stated that the cost would probably be as high as $5,000,000 for the Government and that it would cost the railroads as much more and take four years to complete the work. Railroad officials who appeared before the Senate committee at hearings on the bill which was finally passed also greatly underestimated the cost, as they stated that the work would cost the railroad companies and the Government each about $3,000,000.

In August, 1913, after the passage of the act and when the plans were fairly well formulated as to the method of handling the work, the Interstate Commerce Commission estimated that the Government expenditure would be from $10,000,000 to $15,000,000 and that the work would take about seven years to complete. A year and a half after the passage of the act Director Prouty in his speech before the National Association of Railway Commissioners on Nov. 17, 1914, stated that the expense to the Government would be about $16,000,000 for obtaining cost of reproduction and for the accounting work and that it was likely the cost to the railroads would be from $25,000,000 to $35,000,000, which would mean a total cost of nearly $50,000,000—quite a different estimate from that made at the time of the passage of the act. As to the length of time that it will take to do this work, two years have elapsed since the passage of the act, and up to about the first of January field work has been completed on about 11,000 mi. Allowing a year to get the work under way, it is safe to state that 11,000 mi. has been completed in one year. Directer Prouty has stated that sufficient parties should be in the field by July 1, 1915, to complete 4000 mi. per month, or 48,000 per year, which would mean that from July 1, 1915, it will take practically five years to complete the work. This estimate is based on past results, generally on smaller roads, and it is probable that work cannot proceed so rapidly on the larger systems, so that it seems probable that this time limit may be exceeded.

Valuation Organization by the Railways

On the passage of the Valuation Act it became necessary for the railroad companies to establish an organization which would enable them to keep in touch with the progress of the work and provide the required coöperation with the Government. Practically all the railroad companies in the country joined in the formation of what is known as the President's Conference Committee. This committee consists of 18 railroad presidents under the general chairmanship of Samual Rea, president of the Pennsylvania Railroad. This conference committee is divided into three groups—Eastern, Western and Southern—with a chairman for each group.

At the group headquarters there is an engineer reporting to the chairman. There are a number of attorneys attached to the various groups, whose duty it is to consider the legal aspects of the problems confronting them in connection with the work. There have also been formed an engineering committee of 13, an equipment committee of 5, a land committee of 15, and a financial, history, and accounting committee of 13. These committees report to the Presidents' Conference Committee and take under consideration the various questions for which decision is desired by the carriers as to methods of procedure and uniformity of action; and at the same time these committees meet with the various Government boards of similar character to discuss questions which may arise.

Practicaliy all the railroad companies have organized valuation committees, made up of officials of the company, generally composed of representatives of the engineering, motive-power, land, accounting, and legal departments, and in addition a special organization has been formed to carry on the actual preparation of necessary information. The Delaware & Hudson Co. established an organization about Nov. 1, 1913. In addition to the preparation of required maps and profiles, we have made a careful study of the construction history of the road to obtain dates as to the building of the various parts of the system.

One of the most important features of our present work is the study of our records for hidden or obscure items of cost. It is obvious that a field inspection of a property, even with careful measurements taken of all visible features of construction, will not be the true measure of quantities comprised in the property nor give us the true cost or value. For instance, fills have been made on soft ground requiring many yards of earth which cannot be measured, difficult and expensive foundations have been placed under structures which do not show up now, streams and highways have been changed, and innumerable difficulties have been encountered involving heavy expenditures which cannot be determined on the ground.

Our search of the records discloses many of these items in such a way as to be readily verified, also the recollection of older employees and residents along the line gives us information of importance. All these data are collected in such form as to be properly presented to the Government engineers, and will no doubt be accepted.

It is necessary for the carriers to have representatives with the Government parties, who are called pilots, who are supposed to be thoroughly familiar with the property. These pilots will be intrusted with the duty of seeing to it that all visible property of the railroad is measured or noted. Also they must call attention to the hidden and obscure quantities where known to exist, and generally assist the Government party in making an accurate survey of the entire property. The careful training of the pilots is essential, and the men who are now working up the preliminary information will later be used by the carriers as their pilots.

The Delaware & Hudson Co.'s lines are made up of 11 different active corporations, while the total number of

corporations that have been organized during the history of the company is 47.

The first railroad track built on the Delaware & Hudson was completed and put in operation in 1829 between Carbondale and Honesdale. This consisted of hemlock stringers with iron strap rail to reduce wear. The motive power was gravity and horses. The first locomotive engine that ever ran on rails in this country was the "Stourbridge Lion," which ran a trial trip over a part of this track on Aug. 8, 1829. While the success of this means of locomotion was assured by this experimental trip, the locomotive was not used in regular traffic, it being found that the track and trestles supporting it over streams were not of sufficient strength to carry it.

The first line which now makes up the Delaware & Hudson system on which steam power was used regularly is that between Saratoga and Schenectady, which was built in 1832 from Schenectady to Ballston and completed in 1833 to Saratoga. In 1835 the line from Troy to Ballston was built and in 1850 was completed through to Whitehall. The line along Lake Champlain to the Canada line was built in the '70's and completed in 1876. The line between Albany and Binghamton was completed in 1869, having been under construction for about ten years. About 87% of the Delaware & Hudson system was built prior to 1880, so that it becomes rather difficult to get satisfactory records of construction carried on more than 30 years ago.

It is of the utmost importance that all quantities should be carefully measured and every possible allowance made to the railroad companies for the full amount of tangible property.

New Chittenden Plant of the Pittsford Power Co.

By Thomas Fraher*

SYNOPSIS—The highest-head plant in the East develops 3700 hp. from water flowing between two reservoirs and previously unutilized. A notable feature is a 2¼-mile length of Oregon fir pipe. Some interesting notes on construction methods for a small plant are appended.

The recently completed hydro-electric development of the Pittsford Power Co. in Chittenden, Vt., 7 mi. north of Rutland, is of unusual interest, since it has the highest head in the East and a long wood-stave penstock built mostly of Oregon fir. A short run of pipe made from local spruce allows comparison of two materials and shows the advantages of the Western lumber.

The plant utilizes storage water from an existing reservoir, the flow from which to a lower reservoir formerly performed no useful work. This reservoir impounded about 800,000,000 cu.ft., which the additional runoff increased to about 1,000,000,000 cu.ft. of water available in an average year. The static head from the top of the flashboards to the weir in the tailrace is 481 ft. Two 1850-hp. units are installed at present, and provision has been made for a third similar unit.

Features of Design

Wood-Stave Pipe—Fig. 2 shows the alignment of the pipe line. Starting at the dam, it is of native spruce for a distance of about 1400 ft., and then of Oregon fir for 12,000 ft. farther, except at a point around a rocky knoll, where the curvature was too short for wood-stave pipe and it was found necessary to insert a steel bend. The gradient to the end of the wood-stave pipe is uniform at 0.3%, but from here the line drops abruptly to the power house through a steel penstock about 2800 ft. long. The spruce staves were made from lumber cut in the adjacent territory and air-dried for nine months. They were then milled to a finished thickness of 2⅝ in. and averaged from 12 to 14 ft. long. The Oregon-fir staves were made from live Douglas fir and were milled to a finished thickness of 2⅛ in., the average lengths running about 20 ft. Thirty-six fir staves made a pipe section of 60 in. inside diameter. The pipe details may be summarized as follows:

Inside and outside of staves milled to true pipe circumference; edges beveled radially; ends butted square and given ⅛x1½-in. saw cut for steel tongues; bands of openhearth steel, ⅝-in. diameter, one with both ends headed and one with rolled threads on each end, bent to pipe circumference and dipped in asphaltum paint before shipping; "noneccentric" malleable-iron dipped shoes; band spacing varied from 3 to 6½ in.; maximum head, 85 ft.

Connection was made between the existing 48-in. outlet valve of the reservoir and the 60-in. wooden penstock through a steel increaser with an 18-in. branch, upon which was placed a 24-in. steel vent pipe 55 ft. high, protected by a double casing of wood staves and electrically heated by a car heater.

Aqueducts—Fig. 2 shows four stream crossings. These were made on steel I-beams supported by 2x8-ft. concrete piers and rubble-stone abutments. The spans are shown in detail in Fig. 4. The distance of the cradles above the top of the flange varied according to their position, so that when the pipe was full the deflection of the beams would bring the staves to a straight line. Both cradles and staves on the trestles were creosoted.

Steel Penstock—At the end of the wood-pipe line is a steel nipple, to which is bolted a butterfly valve, to which in turn is bolted a tapered section, reducing the size from 60 to 54 in. The steel penstock then makes a combined horizontal and vertical curve and runs to the power house through various gradients from 2 to 65%. The steel-pipe data may be thus summarized:

Length of 54-in. lock-bar pipe, 600 ft.; length of 54-in. riveted pipe, 1100 ft.; length of 52-in. riveted pipe, 1050 ft.; thickness varies from ⅜ to ⅞ in. All circumferential seams single riveted; longitudinal seams triple riveted with double butt straps.

The steel penstock is anchored at the angles and there is a heavy reinforced-concrete anchor at the power house.

Surge Tank—Just below the butterfly valve a 48-in. steel-pipe connection is taken off to a surge tank 14 ft. in diameter by 90 ft. high. The top of this is 19 ft. above the flashboards on the dam. After the tank was tested a frost casing, 18 ft. in diameter, made of old 2-in. plank

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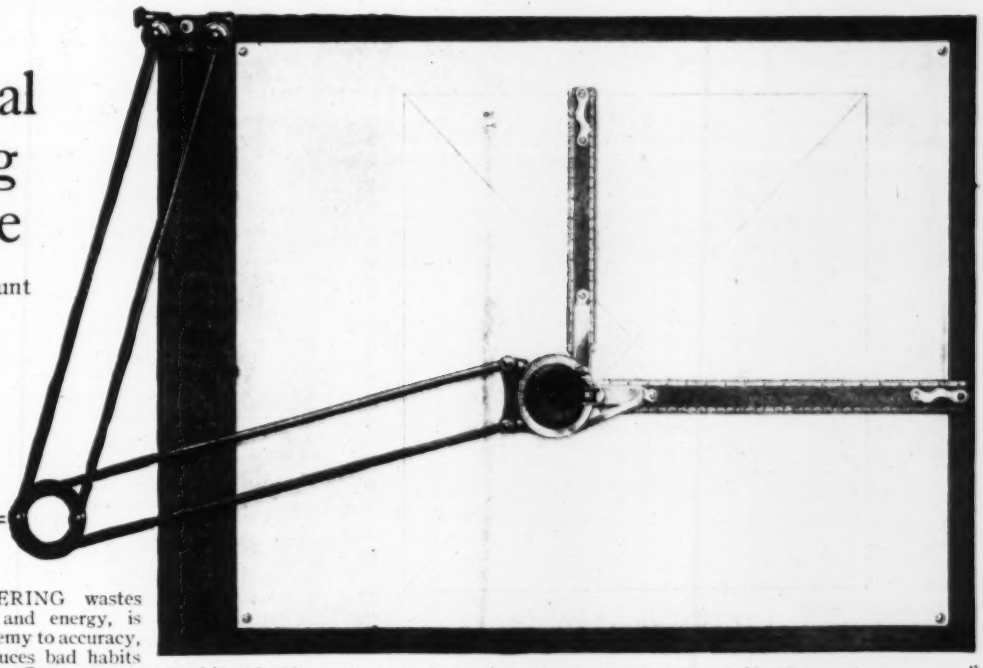

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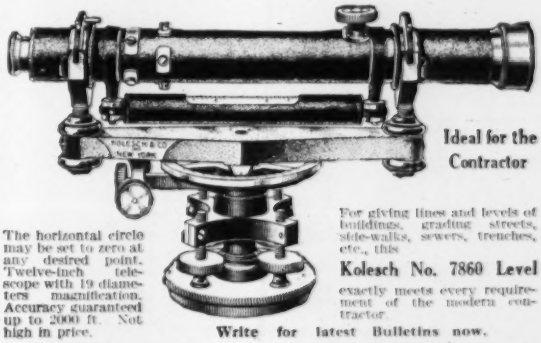

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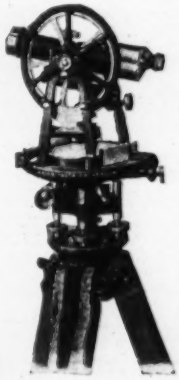

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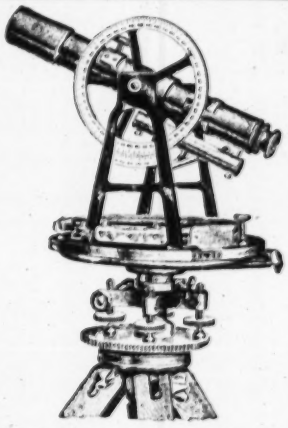

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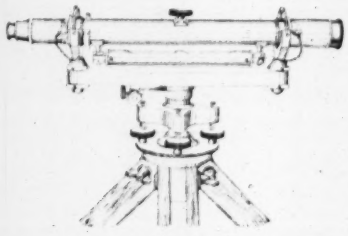

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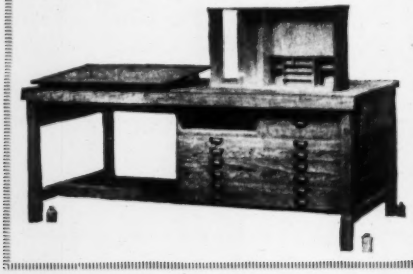

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Cable Excavator Co., Com'l Trust Bldg., Phila
Insley Mfg. Co., Indianapolis, Ind.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y. Ci

Drawing Materials
Aloe Co., A. S., 617 Olive St., St. Louis, Mo.
Hardtmuth, L. & C., 34 E. 23rd St., N. Y. City.
"Kohinoor" brand.
Keuffel & Esser Co., New York. Hoboken, N. J.
Kolesch & Co., New York City.

Drawing Tables
Economy Drawing Table Co., Toledo, Ohio.
Kolesch & Co., New York City.

Dredges
Flory Mfg. Co., S., Bangor, Penn.
Hayward Co., The, 50 Church St., New York City.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y. City.
Marion Steam Shovel Co., Station M, Marion, O.
Morris Machine Works, Baldwinsville, N. Y.

Drills, Air
Chicago Pneumatic Tool Co., Chicago, Ill.

Drills, Core
Ingersoll-Rand Co., 11 Broadway, New York City.
Keystone Driller Co., Beaver Falls, Penn.
McKiernan-Terry Drill Co., 234 Bway., N. Y. C.
Sullivan Mach. Co., 122 S. Mich. Ave., Chicago.

Drills, Electric
Independent Pneumatic Tool Co., Chicago, Ill.

Drills, Hammer
Ingersoll-Rand Co., 11 Broadway, New York City.
"Jackhamer," "Butterfly," "Leyner Ingersoll," "Jackstoper."
McKiernan-Terry Drill Co., 234 Bway., N. Y. C.
Sullivan Mach. Co., 122 S. Mich. Ave., Chicago.

Drills, Pneumatic
Chicago Pneumatic Tool Co., Chicago, Ill.
Independent Pneumatic Tool Co., Chicago, Ill.

Drills, Rock
Ingersoll-Rand Co., 11 Broadway, New York City.
"Butterfly," "Sergeant." Also quarry and submarine types.
Jeffrey Mfg. Co., The, 923 N. 4th St., Columbus, O.
McKiernan-Terry Drill Co., 234 Bway., N. Y. C.
Sullivan Mach. Co., 122 S. Mich. Ave., Chicago.

Dryers
American Blower Co., Detroit, Mich.

Dynamite
Aetna Explosives Co., Inc., 2 Rector St., N. Y. C.

Elevators, Bucket
Jeffrey Mfg. Co., The, Columbus, Ohio.
Ohio Loco. Crane Co., Mansfield St., Bucyrus, O.
Webster Mfg. Co., The, Tiffin, Ohio.

Elevators, Concrete
Ohio Loco. Crane Co., Mansfield St., Bucyrus, O.
Ransome Concrete Machinery Co., Dunellen, N. J.
Cable: Racomaw. Branches: Chicago, Philadelphia, Boston, New York, Columbus, Ohio.
Automatic dump.

Engines, Gas and Gasoline
Alberger Gas Engine Co., 281 Chicago St., Buffalo, N. Y.
Fairbanks-Morse Co., Chicago, Ill.
International Steam Pump Co., 115 Bway., N. Y. C.
National Meter Co., New York City.

Engines, Oil
Fairbanks, Morse & Co., Chicago, Ill.

Engines, Pumping
Blake & Knowles Steam Pump Works, The, East Cambridge, Mass.
Fairbanks, Morse & Co., Chicago, Ill.
International Steam Pump Co., 115 Bway., N. Y. C.
Morris Machine Works, Baldwinsville, N. Y.
Worthington, Henry R., 115 Broadway, N. Y. City.

Engines, Steam
American Blower Co., Detroit, Mich.
Up to 160 hp.
Vertical, Single, double and compound cylinders.
Ball Engine Co., Erie, Penn.
Erie Steam Shovel Co., Erie, Penn.
Lawrence Machine Co., Lawrence, Mass.

Excavating Attachment Derrick
Union Iron Wks., West Shore Sta., Hoboken, N. J.

LEHIGH PORTLAND CEMENT CO.
LEHIGH
ALLENTOWN, PA. - CHICAGO, ILL.

Consider the Trade Mark

It is equivalent to a signature of quality and its fair name is jealously protected by the manufacturer.

The value of any advertising or sales propaganda is made—or broken by the reputation of the trade mark or trade name.

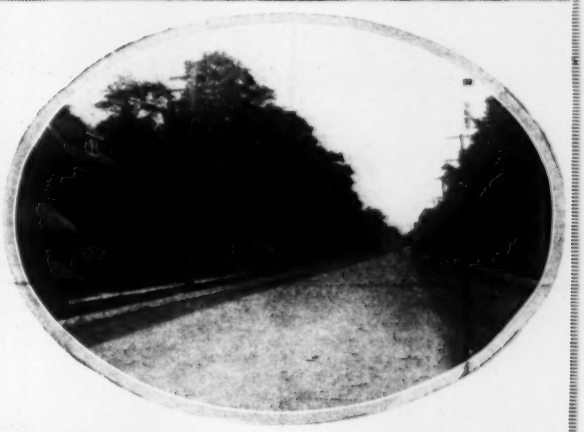
Logically, those firms which feature most their trade mark are most careful in maintaining the quality of their product.

Consider the Trade Mark

LEHIGH CEMENT

Concrete for Permanence

See the Cement Manufacturers' Exhibit at the Cement Show, Chicago, February 12-19.



Anderson Avenue, Bergen County, New Jersey. Standard Mixing Asphalt

Standard Mixing Asphalt For Road Making By the Mixing Process

Assuming the stone to be correctly graded, a successful bituminous concrete roadway depends on the quality of the asphalt. We have developed especially for this purpose

STANDARD MIXING ASPHALT

Standard Mixing Asphalt, like all other Standard Asphalts, has great cementing strength at both high and low temperatures, and high ductility. It is not necessary to cut this asphalt back with a flux, for it is prepared to the correct consistency to bind the stones thoroughly together.

Standard Mixing Asphalt is 99.8% pure, running from 5 to 33% purer than the so-called natural asphalts.

Further information willingly supplied. Ask for facts regarding our Standard Paving Asphalts and Standard Asphalt Binders.

STANDARD OIL COMPANY
(New Jersey)

Newark Baltimore

Geo. W. Lamson, Agent, Ry. Exch. Bldg., Chicago, Ill.

Excavating Machinery
Ball Engine Co., Erie, Penn.
Browning Co., The, Cleveland, Ohio.
Cable Excavator Co., Com'l Trust Bldg., Phila.
Carson Trench Machine Co., Boston, Mass.
Erie Steam Shovel Co., Erie, Penn.
Insley Mfg. Co., Indianapolis, Ind.
Marion Steam Shovel Co., Station M, Marion, O.
Smith Co., The T. L., 1170 32nd St., Milwaukee.
"Albrecht" excavator and loader.

Excavators, Drag Line
Hayward Co., The, 50 Church St., New York City.
Insley Mfg. Co., Indianapolis, Ind.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y. City.
Parsons Co., Newton, Ia. Br., 50 Church, N. Y. C.

Expanded Metal
Berger Mfg. Co., The, Canton, Ohio.
Trussed Concrete Steel Co., Dept. 12, Youngstown, Ohio.
"Kahn" building specialties.
Representatives in principal cities.

Expansion Joints
Alberger Heater Co., 281 Chicago St., Buffalo, N. Y.

Explosives
Aetna Explosives Co., 2 Rector St., N. Y. City.

Facings, Foundry
American Blower Co., Detroit, Mich.

Filing Cases
Economy Drawing Table Co., Toledo, Ohio.

Filters, Water
American Water Softener Co., Philadelphia, Pa.
N. Y. Cont'l Jewell Filtration Co., New York.
Norwood Engr. Co., Florence, Mass.
Pittsburgh Filter Mfg. Co., Pittsburgh, Penn.
Roberts Filter Mfg. Co., Darby, Penn.

Flooring
Berlin Mills Co., Portland, Maine.
Jennison-Wright Co., 320 Huron St., Toledo, Ohio.
Johns-Manville Co., H. W., New York City.
Leopold & Co., Jas., 233 Broadway, New York.
Youngstown Iron & Steel Co., Youngstown, Ohio.

Flumes, Metal
Hinman Hydr. Mfg. Co., 1400 W. Colfax, Denver.

Form Clamps
Insley Mfg. Co., Indianapolis, Ind.
New England Column Clamp Co., Boston, Mass.

Forms, Metal, for Concrete
American Bridge Co., 30 Church St., N. Y. City.
Blaw Steel Construction Co., Pittsburgh, Penn. 165 Broadway, N. Y. City. Peoples Gas Bldg., Chicago.
Standard forms for general work or special forms to order. Sectional or collapsible.
See advertisement.
Hydraulic Pressed Steel Co., 3152 E. 61st St., Cleveland, Ohio.
These forms consists of a framing of upright and horizontal bars, fitted with clamps to secure panels, which constitute the face of the form. The main vertical pieces are U-shaped, flared at the wall and having slotted keyways in the back. The form boards, or panels, are 36x36 in., of wood, faced and edged with pressed steel. Clamps of U-shape, held to the vertical pieces by bolts or keys fitting into the keyholes, straddle the vertical piece and are driven home by wedges until they are tight against the backs of the form boards. When these boards are to be removed, the wedges are slacked and the clamps are turned parallel to the upright piece. Two men with hammers can erect the forms or remove them.

Foundations
MacArthur Concrete Pile & Foundation Co., 11 Pine St., New York City.
Simplex Concrete Piling Co., Tacony, Phila., Pa.
Underpinning & Foundation Co., 290 Broadway, New York City.

Foundation Test Boring
Phillips & Worthington, 90 West St., N. Y. City.

Frogs and Switches
Ramapo Iron Works, Main Office, Hillburn, N. Y.

Furnaces, Annealing and Tempering
American Gas Furnace Co., 24 John St., N. Y. C.
Whiting Foundry Equipment Co., Harvey, Ill.

Furnaces, Gas
American Gas Furnace Co., 24 John St., N. Y. C.

Gages
Southwark Fdry. & Mach. Co., Philadelphia, Pa.

Gages (Loss of Head)
Simplex Valve & Meter Co., Philadelphia, Penn.

Gages (Rate of Flow)
Simplex Valve & Meter Co., Philadelphia, Penn.

Garbage Disposal Apparatus
Bartlett & Snow Co., The C. O., Cleveland, Ohio.

Gas Holders
Wood & Co., R. D., Philadelphia, Penn.

Gas Producer Plants
Improved Equipment Co., 60 Wall St., N. Y. City.

Gas Producers
International Steam Pump Co., 115 Bway., N. Y. C.
Wood & Co., R. D., Philadelphia, Penn.

Gate Hoists
Whiting Foundry & Equipment Co., Harvey, Ill.

Generators
Southwark Fdry. & Mach. Co., Philadelphia, Pa.

Generators, Electric
Fairbanks, Morse & Co., Chicago, Ill.

Graders
Austin Mfg. Co., Chicago, Ill.

Granite
Master Builders Co., The, Cleveland, Ohio.

Gratings, Subway
Irving Iron Works, Long Island City, N. Y.

Grinders, Pneumatic
Independent Pneumatic Tool Co., Chicago, Ill.

Hammers, Pneumatic
Independent Pneumatic Tool Co., Chicago, Ill.

Hammers, Steam
McKiernan-Terry Drill Co., 234 Bway., N. Y. C.
Union Iron Wks., West Shore Sta., Hoboken, N. J.

Heaters, Feed Water
Alberger Heater Co., 281 Chicago St., Buffalo, N. Y.
Alberger Pump & Condenser Co., New York City.
Blake & Knowles Steam Pump Works, The, East Cambridge, Mass.
International Steam Pump Co., 115 Bway., N. Y. C.

Heaters, Service
Alberger Heater Co., 281 Chicago St., Buffalo, N. Y.

Hoists
Dake Engine Co., Grand Haven, Mich.
Fairbanks, Morse & Co., Chicago, Ill.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y. City.
Nat'l Hoisting Eng. Co., Bergen St., Harrison, N. J.
Southwark Fdry. & Mach. Co., Philadelphia, Pa.
Vulcan Iron Wks., 1736 Main St., Wilkes-Barre, Penn.

Hoists, Electric
Fairbanks, Morse & Co., Chicago, Ill.
Flory Mfg. Co., S., Bangor, Penn.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y. City.
Nat'l Hoisting Eng. Co., Bergen St., Harrison, N. J.
Northern Engineering Works, Detroit, Mich.

Hoists, Pneumatic
Chicago Pneumatic Tool Co., Chicago, Ill.

Hoists, Portable Pneumatic
Ingersoll-Rand Co., 11 Broadway, New York City.

Hoisting Drums
Hayward Co., The, 50 Church St., New York City.

Hoisting Engines
Fairbanks, Morse & Co., Chicago, Ill.
Flory Mfg. Co., S., Bangor, Penn.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y. City.
Nat'l Hoisting Eng. Co., Bergen St., Harrison, N. J.

Hose, Metallic
American Metal Hose Co., Waterbury, Conn.
Pennsylvania Flexible Metallic Tubing Co., Broad and Race Sts., Philadelphia, Penn.

Hose, Steam
American Metal Hose Co., Waterbury, Conn.
Pennsylvania Flexible Metallic Tubing Co., Broad and Race Sts., Philadelphia, Penn.

Hose, Suction
American Metal Hose Co., Waterbury, Conn.
Pennsylvania Flexible Metallic Tubing Co., Broad and Race Sts., Philadelphia, Penn.

Humidifiers
American Blower Co., Detroit, Mich.
From 3000 cu.ft. upward.

Hydrants
Eddy Valve Co., Waterford, N. Y.
McKim Foundry & Machine Co., Lockport, N. Y.
Norwood Engr. Co., Florence, Mass.
Rensselaer Valve Co., Troy, N. Y.
Wood & Co., R. D., Philadelphia, Penn.

Hydraulic Accumulators
Southwark Fdry. & Mach. Co., Philadelphia, Pa.

Hydraulic Machinery
Southwark Fdry. & Mach. Co., Philadelphia, Pa.

Hydraulic Presses
Southwark Fdry. & Mach. Co., Philadelphia, Pa.
Wood & Co., R. D., Philadelphia, Penn.

Indicator Posts
Wood & Co., R. D., Philadelphia, Penn.

Inks and Adhesives
Higgins & Co., C. M., 271 9th St., Brooklyn, N. Y.

Inserts for Concrete
Trussed Concrete Steel Co., Dept. 12, Youngstown, Ohio.
"Trus-Con Slotted," "Kahn Adjustable" and "Trus-Con National Socket" inserts.
Representatives in principal cities.

Instruments, Drawing
Aloe Co., A. S., 617 Olive St., St. Louis, Mo.
Dietzgen Co., Eugene, Chicago, Ill.
Keuffel & Esser Co., New York. Hoboken, N. J.
Lufkin Rule Co., Saginaw, Mich. N. Y. City.

Instruments, Mathematical
Aloe Co., A. S., 617 Olive St., St. Louis, Mo.
Keuffel & Esser Co., New York. Hoboken, N. J.

Instruments, Surveying
Ainsworth & Sons, Wm., Denver, Colo.
Aloe Co., A. S., 617 Olive St., St. Louis, Mo.
Bausch & Lomb Optical Co., 700 St. Paul St., Rochester, N. Y.
Berger & Sons, C. L., 35 William St., Boston.
Transits and levels in 19 different types and sizes.
Buff & Buff Mfg. Co., Jamaica Plain, Boston.
Branches: 50 Church St., New York City; 1742 Monadnock Block, Chicago.
Four to 10-inch transits. Twelve to 22-inch levels.
See advertisement.
Dietzgen Co., Eugene, Chicago, Ill.
Guler & Bluhm, 547 Front St., Troy, N. Y.
Gurley, W. & L. E., Troy, N. Y., and Seattle.
Fourteen types of transits for surveyors, engineers and builders. Surveyors' compasses. Seven types of levels—special devices.
Keuffel & Esser Co., New York. Hoboken, N. J.
Kolesch & Co., 138 Fulton St., New York City.
Leupold & Voelpel, Portland, Oregon.
Weiss Instr. Co., 1622 Arapahoe Bldg., Denver.
Transits, levels and prism binoculars.
Williams, Brown & Earle, Philadelphia, Penn.

Intensifiers
Southwark Fdry. & Mach. Co., Philadelphia, Pa.

Jacks
McKiernan-Terry Drill Co., 234 Bway., N. Y. C.
Southwark Fdry. & Mach. Co., Philadelphia, Pa.

Joints, Expansion
(See Paving Joints, Expansion)

Joints, Flexible Pipe
Coldwell-Wilcox Co., Newburgh, N. Y.

Kettles, Asphalt and Tar
Union Iron Wks., West Shore Sta., Hoboken, N. J.

Lime Kilns
Improved Equipment Co., 60 Wall St., N. Y. City.

Loaders, Wagon
Jeffrey Mfg. Co., The, Columbus, Ohio.

Locomotives, Electric
Robins Conveying Belt Co., 14 Park Row, N. Y. C.

Locomotives, Industrial
Jeffrey Mfg. Co., The, 923 N. 4th St., Columbus, O.
Robins Conveying Belt Co., 14 Park Row, N. Y. C.
Vulcan Iron Works, 1736 Main St., Wilkes-Barre.

Lumber
Berlin Mills Co., Portland, Maine.
Bowers Co., S. P., 112 N. Broad St., Phila., Pa.

Manometers
Simplex Valve & Meter Co., Philadelphia, Penn.

Meters, Boiler Feed Water
Builders Iron Foundry, Providence, R. I.
International Steam Pump Co., 115 Bway., N. Y. C.
Pittsburgh Meter Co., East Pittsburgh, Penn
Worthington, Henry R., 115 Broadway, N. Y. City.

Meters, Current
Gurley, W. & L. E., Troy, N. Y., and Seattle.
"Price"—acoustic, electric recording or telephone indicating.
Ritchie & Sons, E. S., 112 Cypress St., Brookline, Mass.

Meters, Oil and Gas
Builders Iron Foundry, Providence, R. I.
Hersey Mfg. Co., South Boston, Mass. Cable: Boston, Quohersey. Branches: Boston, N. Y., Phila., Buffalo, Chicago, Columbus, O.; Atlanta, San Francisco, Los Angeles, Portland, Ore.
International Steam Pump Co., 115 Bway., N. Y. C.
National Meter Co., 84 Chambers St., N. Y. City.
Pittsburgh Meter Co., East Pittsburgh, Penn.
Worthington, Henry R., 115 Broadway, N. Y. City.

Meters, Steam
Builders Iron Foundry, Providence, R. I.

History in 4 Chapters—Read 'em!

Chapter No. 1. A big metal mine operator said "Don't show me how hard your shovel is or show me any photographs or read any letters of praise. Send me two shovels. I will put them to work and I'll know very shortly whether or not they are worth anything." We sent two.

Chapter No. 2. Letter from operator: "Those two shovels did wonderful work—too wonderful to last; send me 3 dozen and I will test further." We did.

Chapter No. 3. Letter from operator: "Although those three dozen shovels behaved as well as the two—I still cannot believe that shovels even of chrome nickel steel could always be as good. Enclosed find order for 40 dozen and I will this time give you a good swing." We filled his order.

Chapter No. 4. We are getting all the business of that operator.

WYOMING-MAYARI RED EDGE SHOVELS

The only trouble with this operator was that he was using his old standards of shovel life and performance and had not fully realized that Wyoming, Mayari Shovels with Chrome Nickel Steel Blades, with Extra Selected Handles, must necessarily give at least twice the service of the best crucible steel shovels that can possibly be made.

When once this is realized and it is understood that Wyoming-Mayari Shovels are as radical and as real an improvement in their field as steel freight cars are in theirs and steam turbines are in theirs, then you can understand why these shovels do the wonderful things they do, so easily,

Ask us **now** for "Scientific Shoveling" and a catalog. We'll send you a dozen shovels on trial if you say so.

WYOMING SHOVEL WORKS
Wyoming, Penn.

THE MINIMUM LOADING COST

is entirely dependent on each individual job. The Omaha Water Board extended the power charger frame on their Smith Mixer and loaded the skip 39 feet below the machine. But this flexibility of their Smith equipment saved them the cost of distributing towers and hoisting engines. Naturally there are many installations which require power chargers or batch hoppers but the loading method which produces the lowest cost is

LOW-CHARGING

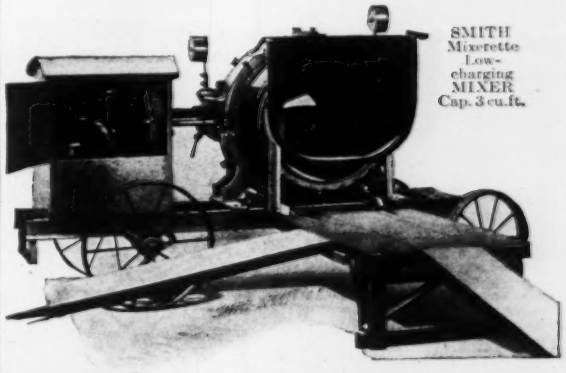
There is economy in using a Smith-Chicago Low-Charger on your work. It's mighty easy to run your barrows up the short plank to the low platform only 18 inches high on the Smith Mixerette, upend them and dump the materials directly into the drum. Every machine is guaranteed against splashing and to discharge the entire batch in from 12 to 14 seconds. S-C Low-Chargers are built in four sizes—3 ft., 4 ft., 6 ft. and 9 ft. of mixed concrete per batch.

Which Catalog do you want?

Smith Mixer Cat. No. 51-B. Smith-Chicago Cat. No. 10-B.
S-C Low-Charger Cat. No. LC-1-B.

The T. L. SMITH CO.

1126-B Thirty-Second St., MILWAUKEE, WIS.
1404-B Old Colony Building, CHICAGO, ILL.



SMITH Mixerette Low-charging MIXER Cap. 3 cu. ft.

Meters, Water
Builders Iron Foundry, Providence, R. I. Branches: 30 Church St., N. Y. City; 2137 Oliver Bldg., Pittsburgh; 549 The Rookery, Chicago.
Venturi type. Standard sizes 2 to 60"; larger sizes to order. Capacity—standard tubes from 3 gal. per m. minimum to 36,100 gal. per m. maximum. Weights from 50 to 58,300 lb.
Contracted tube causing difference between pressures at contraction and inlet. Differences in pressure transmitted by small piping to indicating-recording and register indicator-recording instruments, where difference in pressure is translated into rate of flow units.
Agents: N. B. Livermore & Co., San Francisco; Northwest. Equip. Co., Portland, Ore., Seattle.
Hersey Mfg. Co., South Boston, Mass. Cable: Boston, Quohersey. Branches: Boston, N. Y., Phila., Buffalo, Chicago, Columbus, O.; Atlanta, San Francisco, Los Angeles, Portland, Ore.
International Steam Pump Co., 115 Bway., N. Y. C.
National Meter Co., 84 Chambers St., N. Y. City.
Pittsburgh Meter Co., East Pittsburgh, Pa. Cable: "Meter," Pittsburgh. Branches: New York, Chicago, Kansas City, Columbia, S. C., Seattle.
Ritchie & Sons, E. S., 112 Cypress St., Brookline, Mass.
Simplex Valve & Meter Co., Philadelphia, Penn. "Venturi," "Pitot Tube," "V Notch Wier," "Rectangular Wier," "Orifice."
Thomson Meter Co., 110 Bridge St., Bklyn., N. Y. One model, eight sizes—⅝ to 6". Made in bronze only.
Worthington, Henry R., 115 Broadway, N. Y. City.

Mixers, Asphalt
Smith Co., The T. L., 1170 32nd St., Milwaukee.

Mixers (Heated), Asphalt and Concrete
Smith Co., The T. L., 1170 32nd St., Milwaukee. See "Mixers, Asphalt."

Mixers, Concrete
Foote Mfg. Co., Nunda, N. Y.
Nine sizes, ¼ to 1 cu.yd. capacity.
Agents: Foote Concrete Mchy. Co., Chicago; Wilcox Bros., Inc., and E. J. McHarg & Co., Binghamton, N. Y.; W. C. McAnlis, Detroit; C. W. Klapproth, New York; Edward R. Bacon Co., San Francisco; Hallidie Machinery Co., Seattle; Hodson-Feenaughty Co., Portland, Ore.
International Steam Pump Co., 115 Bway., N. Y. C.
Ransome Concrete Machry. Co., Dunellen, N. J. Cable: Racomaw. Branches: Chicago, Philadelphia, Boston, New York, Columbus, Ohio.
Sizes, 4 to 80 cu.ft. Cap. 4 to 80 cu.yd. per hr. Rotary, non-tilting batch type equipped with gasoline, steam or motor drive. All types of feed.
Smith Co., The T. L., 1170 32nd St., Milwaukee. Tilting type, 9 sizes, 4 cu.ft. to 62 cu.ft. mixed concrete. Non-tilting type, 10 sizes, 3 cu.ft. to 80 cu.ft. mixed concrete.

Mixers, Hand
Smith Co., The T. L., 1170 32nd St., Milwaukee. Smith hand mixer, 2½ cu.ft. 1,000 lb., $120.

Mixers, Special
Smith Co., The T. L., 1170 32nd St., Milwaukee. Glass mixers, fertilizer mixers, core-sand mixers, mortar mixers.

Molds, Pipe and Culvert
Blaw Steel Construction Co., Pittsburgh, Penn.

Motors, Electric
Fairbanks, Morse & Co., Chicago, Ill.

Packing Leather
Southwark Fdry. & Mach. Co., Philadelphia, Pa.

Paints
Barrett Mfg. Co., New York, N. Y.
Carey Co., Philip, 18 Wayne Ave., Lockland, Ohio.
Cheesman & Elliot, 100 William St., N. Y. City.
Patterson-Sargent Co., Cleveland, Ohio.

Paints, Graphite
Detroit Graphite Co., 120 Broadway, N. Y. City.
Patterson-Sargent Co., Cleveland, Ohio.

Paints, Marine
Patterson-Sargent Co., Cleveland, Ohio.

Paints, Metal Protective
Detroit Graphite Co., 120 Broadway, N. Y. City.
National Lead Co., 111 Broadway, New York, N. Y. Cable: Leadco. Branches: New York, Boston, Buffalo, Chicago, Cincinnati, Cleveland, St. Louis, San Francisco.
Steel packages of 12½, 25, 50 and 100 lb. net weight. Price: 100 lb. at 8¼c. per lb.; 25 and 50 lb. at 8½ c. per lb.; 12½ lb. at 8¾c. per lb. On lots of 500 lb. or more prices are ½c. per lb. less. F.o.b. shipping point.
"Dutch Boy" red lead in oil.—A protective paint for iron and steel. Red, brown, green and black.
Patterson-Sargent Co., Cleveland, Ohio.

Paper, Blueprint
Keuffel & Esser Co., New York. Hoboken, N. J.

Pavements
Jennison-Wright Co., 320 Huron St., Toledo, Ohio.

Paving Blocks, Creosoted Wood
Barber Asphalt Paving Co., Maurer, N. J.
Jennison-Wright Co., 320 Huron st., Toledo, Ohio.
All sizes from 3 to 4" in depth.
"Kreolite" lug wood blocks are manufactured with 2 "V"-shaped compressible lugs on one side and one lug on one end, providing a space between each separate row of blocks, giving foothold for horses. When the blocks expand the lugs compress, preventing buckling and bleeding of the floor or pavement.
Eastern Representative, L. P. Drinker, 911 Crozier Bldg., 1420 Chestnut St., Philadelphia, Pa. Western Representative: F. E. Jennison, F. M. Enright, 138 N. La Salle St., Chicago, Ill. Canadian Representative: Frank B. Goodman, 270 Yonge St., Toronto, Ontario.
Wyckoff Pipe & Creosoting Co., New York City.

Paving Blocks, Kyanized Wood
Berlin Mills Co., Portland, Maine.

Paving Brick (Vitrified)
Bessemer Lime Stone Co., Youngstown, Ohio.
Bessemer block, wire-cut-lug and repressed.
National Paving Brick Mfgrs. Asso., Cleveland, O. An association organized for a dissemination of technical knowledge relating to the use of vitrified brick as a paving material and to influence to the greatest possible extent the proper construction of brick streets and roads.

Paving Joint Filler
Barrett Mfg. Co., New York, N. Y.

Paving Joints, Expansion
Carey Co., Philip, 18 Wayne Ave., Lockland, O.
Trussed Concrete Steel Co., Dept. 12, Youngstown, Ohio.
"Kahn Armor Plate" and "Kahn Elastic Filler." Representatives in principal cities.

No use to file this list for future reference, a new one will be out next week, right up to the minute

Pencils
Hardtmuth, L. & C., 34 E. 23rd St., N. Y. City.
'Kohinoor' brand for the office and drafting room.

Piles, Concrete
MacArthur Concrete Pile & Foundation Co., 11 Pine St., New York City. Branch offices in principal cities.
The "Pedestal" pile, made-in-place with 16-inch diameter cylindrical shaft and 3-foot diameter base. Made by driving core and casing into ground; ramming out concrete to form base; filling casing with concrete and removing casing; leaving completed pile in place.
Raymond Concrete Pile Co., 140 Cedar St., New York, N. Y. Branches: Chicago, Pittsburgh, Boston, Baltimore, Philadelphia, Atlanta, Detroit, Cleveland, St. Louis, Portland, Oregon; San Francisco, Los Angeles, Omaha, Cincinnati, St. Paul, Kansas City and Montreal.
The "Raymond Standard" concrete pile is of the cast-in-place type and is made by driving an expanded steel core, covered with a reinforced sheet steel shell, into the ground to proper resistance. The core is collapsed and withdrawn and the shell left in the ground, inspected and filled with concrete. The concrete and its protecting shell form the completed pile.
See ad. always on page 3.
Simplex Concrete Piling Co., Tacony, Phila., Pa.
Underpinning & Foundation Co., 290 Broadway, New York City.

Pile Drivers
Browning Co., The, Cleveland, Ohio.
McKiernan-Terry Drill Co., 234 Bway., N. Y. C.
Union Iron Wks., West Shore Sta., Hoboken, N. J.

Pile Hammers
National Hoisting Engine Co., Harrison, N. J.

Piling, Sheet Steel
Lackawanna Steel Co., Lackawanna, N. Y. Branches: New York, Boston, Buffalo, Philadelphia, Cleveland, Cincinnati, Chicago, Detroit, St. Louis, Atlanta, San Francisco.
Arched-web, straight-web, center-flange, plate steel and protected types. Lengths and strengths suitable to cofferdam, retaining wall, core wall, curtain wall, shore revetment work, etc.
See advertisement.

Piling, Steel
Underpinning & Foundation Co., 290 Broadway, New York City.

Piling, Wood
Berlin Mills Co., Portland, Maine.
Bowers Co., S. P., 112 N. Broad St., Phila., Pa.
Jennison-Wright Co., 320 Huron St., Toledo, Ohio.

Pipe Covering
Carey Co., Philip, 18 Wayne Ave., Lockland, Ohio.
Johns-Manville Co., H. W., New York, N. Y.
"Asbestocel"—low-pressure steam and heating. "Asbesto-Sponge Felted"—high-pressure and superheated steam—and others.
Wyckoff & Son, A., Elmira, N. Y.

Pipe Fittings
American Pipe & Construction Co., 112 N. Broad St., Philadelphia, Penn.
Builders Iron Foundry, Providence, R. I.
Southwark Fdry. & Mach. Co., Philadelphia, Pa.

Pipe, Iron
American Cast Iron Pipe Co., Birmingham, Ala.
American Pipe & Construction Co., 112 N. Broad St., Philadelphia, Penn.
Central Foundry Co., 90 West St., N. Y. City.
Clow & Sons, Jas. B., Chicago, Ill.
Donaldson Iron Co., Emaus, Lehigh County, Pa.
Fox & Co., John, 253 Broadway, New York City.
Glamorgan Pipe & Foundry Co., Lynchburg, Va.
Lynchburg Foundry Co., Lynchburg, Va.
Massillon Iron & Steel Co., Masillon, Ohio.
National Tube Co., Pittsburgh, Penn.
Standard Cast Iron Pipe & Fdry. Co., Bristol, Pa.
United States Cast Iron Pipe & Foundry Co., Philadelphia, Penn.
Warren Fdry. & Machine Co., 11 Bway., N. Y. C.
Wood & Co., R. D., 400 Chestnut St., Phila., Pa.

Pipe Joint Compounds (Pressure)
Leadite Co., Inc., The, Land Title Bldg., Philadelphia, Penn.

Pipe, Reinforced Concrete
Lock Joint Pipe Co., 165 Broadway, N. Y. City.

Pipe, Riveted Steel
East Jersey Pipe Co., Fulton and Church Sts., New York City.
Gillespie Co., The T. A., 50 Church St., N. Y. C.
Kittoe Boiler & Tank Co., Canton, Ohio.
McNeil & Bro., James, Pittsburgh, Penn.
Riter-Conley Mfg. Co., Pittsburgh, Penn.
Struthers-Wells Co., Warren, Penn. N. Y. City.
Tippett & Wood, Phillipsburg, N. J.
Weigele Riveted Steel Pipe Works, Denver, Colo.

Pipe Specials
Builders Iron Foundry, Providence, R. I.
Wood & Co., R. D., 400 Chestnut St., Phila., Pa.

Pipe, Steel
National Tube Co., Pittsburgh, Penn.

Pipe, Wood
Michigan Pipe Co., Bay City, Mich.
National Tank & Pipe Co., Portland, Oregon.
Two inches to 14 feet diameter, up to 300' head.
Pacific Tank & Pipe Co., 5th and Bryant St., San Francisco.
Portland Wood Pipe Co., Portland, Oregon.
Redwood Manufacturers Co., 1605 Hobart Bldg., San Francisco, Calif.
Standard Wood Pipe Co., Williamsport, Penn.
Washington Pipe & Foundry Co., 1512-1620 Center St. and 3001-3019 Asotin St., Tacoma, Wash. Cable: Wash Pipe.
Sizes from 2 inches up. Machine banded, continuous stave and special pipe.
Wyckoff & Son Co., A., Elmira, N. Y.
Wyckoff Pipe & Creosoting Co., New York City.

Pitometers
Pitometer Co., The, 25 Elm St., New York City.
"Cole" recording pitometers.

Poles, Cross-Arms, Etc. (Treated Wood)
Berlin Mills Co., Portland, Maine.
National Tank & Pipe Co., Portland, Oregon.

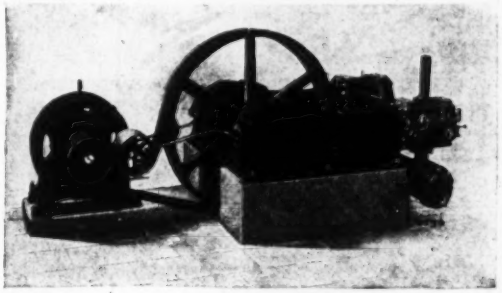
Poles, Tubular Steel
American Bridge Co., 30 Church St., N. Y. City.
Franklin Steel Works, Franklin, Penn.
Mill capacity, 100 poles per day.
Various types for all electric service.
National Tube Co., Pittsburgh, Penn.

Portable Pneumatic Hoists
Ingersoll-Rand Co., 11 Broadway, New York City.

Powder
Aetna Explosives Co., Inc., 2 Rector St., N. Y. C.

Power Transmission Machinery
Bacon, Earle C., Havemeyer Bldg., New York.
Leffel & Co., James, Springfield, Ohio.
Jeffrey Mfg. Co., The, 923 N. 4th St., Columbus, O.
Webster Mfg. Co., The, Tiffin, Ohio.

AIR COMPRESSORS



Imperial Type Ten Steam or Belt Driven Air Compressors. Capacities 176—3508 cu.ft.

Bulletins 3311-3312

Ingersoll-Rand Air Compressors are built in a complete range of types and sizes—each of which is designed and built to furnish a dependable supply of air at the lowest cost for operation and attendance.

Ingersoll-Rand Compressors are wholly enclosed and automatically lubricated. Air cylinders are completely water jacketed on barrels and heads and ample intercoolers are provided between stages of compound machines. Air valves have proven in continued service to be most efficient and thoroughly reliable.

Power is applied in the most economical way, power consumption, whether a belt, electric, oil or steam engine driven unit, is reduced to a minimum.

INGERSOLL-RAND COMPANY

New York **Offices the World Over** **London**

147-C

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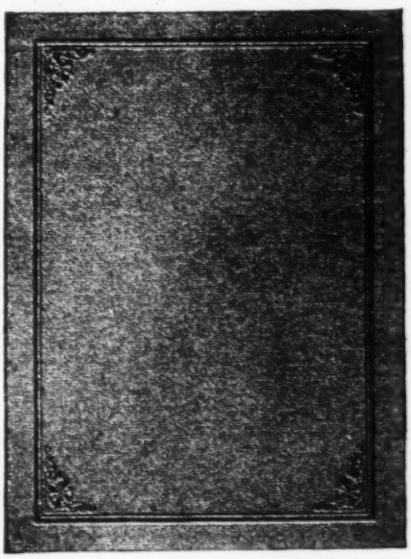

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form. You wouldn't say that it isn't worth 50 cents to you, would you? That is the price, prepaid to your door. Send your order now.

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ENGINEERING NEWS, 10th AVE. at 36th ST., NEW YORK

Pumps, Air
Blake & Knowles Steam Pump Works, The, East Cambridge, Mass.
Cameron Steam Pump Works, A. S., 11 Broadway, New York City.
Deane Steam Pump Plant, Holyoke, Mass.
International Steam Pump Co., 115 Bway., N. Y. C.
Southwark Fdry. & Mach. Co., Philadelphia, Pa.

Pumps, Air Lift
Harris Air Pump Co., Indianapolis, Ind.
13 sizes—1 to 8". Cap. 5 to 2000 gal. per m.
Ingersoll-Rand Co., 11 Broadway, New York City.
International Steam Pump Co., 115 Bway., N. Y. C.
Sullivan Mach. Co., 122 S. Mich. Ave., Chicago.

Pumps, Centrifugal
Alberger Pump & Condenser Co., New York City.
American Well Works, The, Aurora, Ill.
Cameron Steam Pump Wks., A. S., 11 Broadway, New York City.
Darling Pump & Mfg. Co., Williamsport, Penn.
Fairbanks, Morse & Co., Chicago, Ill.
Goulds Mfg. Co., Seneca Falls, N. Y. Branches: Boston, N. Y., Chicago, Atlanta, Pittsburgh.
International Steam Pump Co., 115 Bway., N. Y. C.
Lawrence Machine Co., Lawrence, Mass.
Lawrence Pump & Engine Co., Lawrence, Mass.
Morris Machine Works, Baldwinsville, N. Y.
Southwark Fdry. & Mach. Co., Philadelphia, Pa.
Worthington, Henry R., 115 Broadway, N. Y. City.

Pumps, Contractors'
Blake & Knowles Steam Pump Works, The, East Cambridge, Mass.
Bond Co., Harold L., Boston, Mass.
Cameron Steam Pump Works, A. S., 11 Broadway, New York City.
Deane Steam Pump Plant, Holyoke, Mass.
Fairbanks, Morse & Co., Chicago, Ill.
International Steam Pump Co., 115 Bway., N. Y. C.
Parker, A. A., Waterford, N. Y.
Pulsometer Steam Pump Co., 18 Battery Pl., N. Y.
The Pulsometer is a self-contained unit which operates by the condensation of steam fed directly to it from a boiler by steam pipe or flexible metallic hose. It contains no pistons, glands, stuffing boxes or eccentrics. Has no mechanical action, therefore requires no lubrication. Requires no auxiliary device to condense its steam, no engine or motor to operate it, and no special foundation or setting, and no special boiler. Usually hung by rope or chains into the excavation where it works. The Pulsometer is designed to handle water containing large percentage of sand, mud, air, pebbles, etc.
Van Nouhuys Mach. Works, Albany, N. Y.
Worthington, Henry R., 115 Broadway, N. Y. City.

Pumps, Deep Well
American Well Works, The, Aurora, Ill.
Blake & Knowles Steam Pump Works, The, East Cambridge, Mass.
Cameron Steam Pump Works, A. S., 11 Broadway, New York City.
Cook, A. D., Lawrenceburg, Ind.
For 2 to 12" wells. Cap. 500 gal. per m.
Fairbanks, Morse & Co., Chicago, Ill.
Goulds Mfg. Co., Seneca Falls, N. Y. Branches: Boston, N. Y., Chicago, Atlanta, Pittsburgh.
International Steam Pump Co., 115 Bway., N. Y. C.
Keystone Driller Co., Beaver Falls, Penn.

Pumps, Diaphragm
Bond Co., Harold L., Boston, Mass.
Boston & Lockport Block Co., Boston, Mass.
Edson Mfg. Co., 278 Atlantic Ave., Boston, Mass.
3 sizes, 2½, 3 and 4" suc. 1800-6000 gal. per hr.
Goulds Mfg. Co., Seneca Falls, N. Y. Branches: Boston, N. Y., Chicago, Atlanta, Pittsburgh.
Parker, A. A., Waterford, N. Y.

Pumps, Dredging
Fairbanks, Morse & Co., Chicago, Ill.
International Steam Pump Co., 115 Bway., N. Y. C.
Lawrence Machine Co., Lawrence, Mass.
Lawrence Pump & Engine Co., Lawrence, Mass.
Morris Machine Works, Baldwinsville, N. Y.
Parker, A. A., Waterford, N. Y.
Worthington, Henry R., 115 Broadway, N. Y. City.

Pumps, Gasoline Portable
Deane Steam Pump Plant, Holyoke, Mass.
Parker, A. A., Waterford, N. Y.

Pumps, Hydraulic
Blake & Knowles Steam Pump Works, The, East Cambridge, Mass.

Pumps, Power
Cook, A. D., Lawrenceburg, Ind.
Deane Steam Pump Plant, Holyoke, Mass.
Fairbanks, Morse & Co., Chicago, Ill.
Goulds Mfg. Co., Seneca Falls, N. Y. Branches: Boston, N. Y., Chicago, Atlanta, Pittsburgh.
McGowan Co., John H., Cincinnati, Ohio.

Pumps, Sinking
Blake & Knowles Steam Pump Works, The, East Cambridge, Mass.

Pumps, Steam
Blake & Knowles Steam Pump Works, The, East Cambridge, Mass.
Cameron Steam Pump Works, A. S., 11 Broadway, New York City.
Deane Steam Pump Plant, Holyoke, Mass.
Fairbanks, Morse & Co., Chicago, Ill.
Keystone Driller Co., Beaver Falls, Penn.
McGowan Co., John H., Cincinnati, Ohio.
Morris Machine Works, Baldwinsville, N. Y.
Pulsometer Steam Pump Co., 18 Battery Pl., N. Y.
Southwark Fdry. & Mach. Co., Philadelphia, Pa.
Worthington, Henry R., 115 Broadway, N. Y. City.

Pumps, Turbine
Alberger Pump & Condenser Co., New York City.
American Well Works, The, Aurora, Ill.
Cameron Steam Pump Works, A. S., 11 Broadway, New York City.
Lawrence Machine Co., Lawrence, Mass.
Lawrence Pump & Engine Co., Lawrence, Mass.
Morris Machine Works, Baldwinsville, N. Y.
Southwark Fdry. & Mach. Co., Philadelphia, Pa.
Worthington, Henry R., 115 Broadway, N. Y. City.

Purifiers, Feed Water
N. Y. Cont'l Jewell Filtration Co., New York.
Norwood Engr. Co., Florence, Mass.

Rails and Fastenings
Lackawanna Steel Co., Lackawanna, N. Y. Branches: New York, Boston, Buffalo, Philadelphia, Cleveland, Cincinnati, Chicago, Detroit, St. Louis, Atlanta, San Francisco.
Standard heavy and light sections, contact rails, angle and splice bars, joint plates, tin plates, track spikes and bolts.

Rail Joints
Rail Joint Co., 185 Madison Ave., New York City.
Base supported rail joints. Types: "Continuous Tee," "Weber Tee," "Walhaupter Tee," "Continuous Step," "Continuous Insulating," "Weber Insulating," "Continuous Girder," "Weber Girder," "Continuous Frog and Switch," "100% Tee Rail Straight Angle Bar" or "Bent Angle Bar." Hot-worked high carbon steel used, oil quenched when desired.

Riveters
Southwark Fdry. & Mach. Co., Philadelphia, Pa.

Rivets
Pennsylvania Steel Co., Steelton, Penn.

Road Oils and Preservatives
Barber Asphalt Paving Co., Maurer, N. J.
Barrett Mfg. Co., New York City.
Standard Oil Co., Newark, N. J.

Road Rollers
Austin Mfg. Co., Chicago, Ill.
Buffalo Steam Roller Co., Buffalo, N. Y.
"Buffalo Pitts." Two and a half to 20 tons.

Rolls, Crushing
Buchanan Co., C. G., 90 West St., N. Y. City.

Roofing
Barrett Mfg. Co., New York, N. Y.
Carey Co., Philip, 18 Wayne Ave., Lockland, Ohio.
Johns-Manville Co., H. W., New York, N. Y.
Asbestos fire and acid resisting. Built-up; Roll—all weights and types; Corrugated; Shingles.

Roofing, Metal
American Sheet & Tin Plate Co., Pittsburgh, Pa.
Berger Mfg. Co., The, Canton, Ohio.
Youngstown Iron & Steel Co., Youngstown, Ohio.

Rope, Manila
Waterbury Co., The, 63 Park Row, N. Y. City.

Rope, Transmission
Waterbury Co., The, 63 Park Row, N. Y. City.
Webster Mfg. Co., The, Tiffin, Ohio.

Rope, Wire
American Steel & Wire Co., Chicago, Ill.
Waterbury Co., The, 63 Park Row, N. Y. City.

Sash, Steel (See Window Sash, Steel)

Screens, Rotary
Jeffrey Mfg. Co., The, Columbus, Ohio.
Webster Mfg. Co., The, Tiffin, Ohio.

Screens, Well
American Well Works, The, Aurora, Ill.

Second-Hand Equipment
(See Alphabetical Index for For Sale Ads.)
Astoria Light, Heat & Power Co., The, East 132d St. and Locust Ave., New York City.

Sharpening Machines (Drill Bit)
Ingersoll-Rand Co., 11 Broadway, New York City.
Sullivan Mach. Co., 122 S. Mich. Ave., Chicago.

Sheaves
Haiss Mfg. Co., 142d St. and Rider Ave., N. Y. C.

Shoes, Wood Pipe
Marion Malleable Iron Works, Marion, Ind.

Shovels, Hand
Wyoming Shovel Works, Wyoming, Penn.

Shovels, Power
Ball Engine Co., Erie, Penn.
"Erie Steam and Electric Revolving Shovels."
Marion Steam Shovel Co., Station M, Marion, O.
Cable: Barnhart. Branches: Atlanta, Chicago, New York, San Francisco, Seattle.
All standard sizes and capacities.
Electric, steam or gasoline power equipment.
Thew Automatic Shovel Co., Lorain, Ohio.

Shutters, Steel and Wood Rolling
Kinnear Mfg. Co., Columbus, Ohio.

Sidewalk Forms
Berger Mfg. Co., The, Canton, Ohio.
Blaw Steel Construction Co., Pittsburgh, Penn.

Skips
Insley Mfg. Co., Indianapolis, Ind.

Sluice Gates
Coldwell-Wilcox Co., Newburgh, N. Y.
Hinman Hydr. Mfg. Co., 1400 W. Colfax, Denver.

Softeners, Water
American Water Softener Co., Philadelphia, Pa.
N. Y. Cont'l Jewell Filtration Co., New York.
Roberts Filter Mfg. Co., Darby, Penn.

Stacks, Steel
Wiederholdt Construction Co., St. Louis, Mo.

Standpipes
Kittoe Boiler & Tank Co., Canton, Ohio.
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.
Struthers-Wells Co., Warren, Penn. N. Y. City.
Tippett & Wood, Phillipsburg, N. J.
Walsh's Holyoke Steam Boiler Works, Holyoke, Mass.

Steam Hammers
Nat'l Hoist. Eng. Co., Bergen St., Harrison, N. J.

Steam Traps
American Blower Co., Detroit, Mich.
Tilting, return, separating, vacuum, condensing.

Steel (Plates and Bars)
Lackawanna Steel Co., Lackawanna, N. Y. Branches: New York, Boston, Buffalo, Philadelphia, Cleveland, Cincinnati, Chicago, Detroit, St. Louis, Atlanta, San Francisco.
Sheared and universal plates, sheet bars, merchant bars in rounds, squares, flats, ovals, half ovals and hexagons.

Steel Plate Construction
American Bridge Co., 30 Church St., N. Y. City.
Blaw Steel Construction Co., Pittsburgh, Penn.
Chicago Bridge & Iron Works, Chicago, Ill.
Coatesville Boiler Works, 30 Church St., N. Y. C.
East Jersey Pipe Co., Fulton and Church St., New York City.
Franklin Steel Works, Franklin, Penn.
Hydraulic Pressed Steel Co., 3152 E. 61st St., Cleveland, Ohio.
Kittoe Boiler & Tank Co., Canton, Ohio.
McNeil & Bro., James, Pittsburgh, Penn.
Pennsylvania Steel Co., Steelton, Penn.
Riter-Conley Mfg. Co., Pittsburgh, Penn.
Struthers-Wells Co., Warren, Penn.
Tippett & Wood, Phillipsburg, N. J.
Walsh's Holyoke Steam Boiler Works, Holyoke, Mass.

Steel, Structural
American Bridge Co., 30 Church St., New York.
Belmont Iron Wks., Phila. 32 Broadway, N. Y. C.
Mill capacity, 4,000 tons monthly.
Berlin Construction Co., Berlin, Conn.
Blaw Steel Construction Co., Pittsburgh, Penn. 165 Broadway, New York City. Peoples Gas Bldg., Chicago.
Case Crane & Engineering Co., Columbus, Ohio.
Chicago Bridge & Iron Works, Chicago, Ill.
Eastern Bridge & Structural Co., Worcester, Mass.
Fort Pitt Bridge Works, Pittsburgh, Penn.
Franklin Steel Works, Franklin, Penn.
Hydraulic Pressed Steel Co., 3152 E. 61st St., Cleveland, Ohio.
Kenwood Bridge Co., Chicago, Ill.
Lackawanna Bridge Co., New York.
Lackawanna Steel Co., Lackawanna, N. Y. Branches: New York, Boston, Buffalo, Philadelphia, Cleveland, Cincinnati, Chicago, Detroit, St. Louis, Atlanta, San Francisco.
Standard structural beams, angles and channels.
MacKinnon-Holmes & Co., Sherbrooke, Que., Can.
McClintic-Marshall Co., Pittsburgh, Penn.
Milwaukee Bridge Co., Milwaukee, Wis.
Minneapolis Steel & Machry. Co., Minneapolis.
Morava Construction Co., Chicago, Ill.
Mount Vernon Bridge Co., Mt. Vernon, Ohio.
Penn Bridge Co., Beaver Falls, Penn.
Phoenix Bridge Co., Phoenixville, Penn.
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.
Riter-Conley Mfg. Co., Pittsburgh, Penn.
Riverside Bridge Co., Martins Ferry, Ohio.
Shoemaker & Co., Lewis F., Pottstown, Penn.
Snare & Triest Co., Woolworth Bldg., N. Y. C.
Strauss Bascule Bridge Co., Chicago, Ill.
Variety Iron & Steel Works, Cleveland, Ohio.
Wisconsin Bridge & Iron Co., Chicago, Ill.

Stokers
Babcock & Wilcox Co., The, 85 Liberty St., New York City. Works: Barberton, Ohio. Branch offices in principal cities.

Strainers, Well
Cook, A. D., Lawrenceburg, Ind.

Superheaters, Steam and Air
Power Specialty Co., 111 Broadway, N. Y. City. Boston, Philadelphia, Pittsburgh, Chicago.

Swinging Gear
Dake Engine Co., Grand Haven, Mich.

An Erie Buyer wrote this Advertisement—

Advertisements have been written by the boss, by the hired man and the professional writer, but when you come right down to search for the ad that carries conviction in every line this is it:

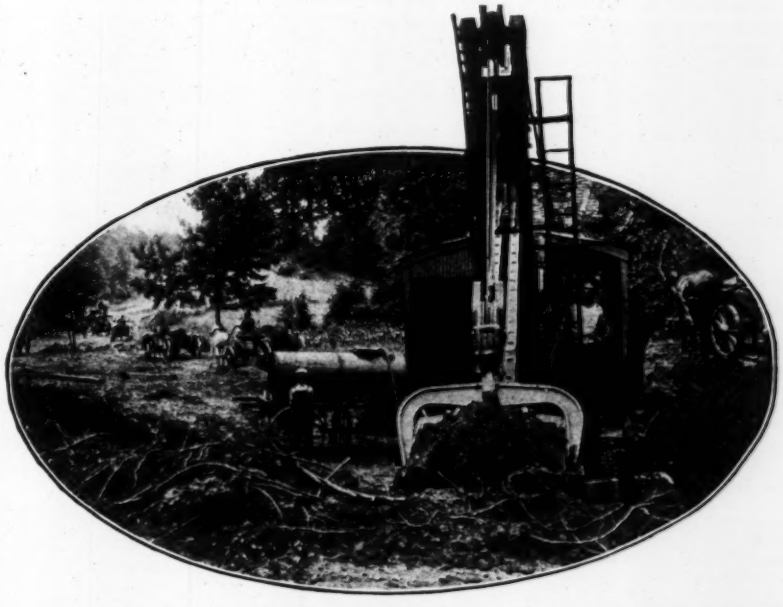
Written by N. H. Battjes, President of the Standard Builders' Supply Company of Grand Rapids, Mich., to a prospective Erie buyer, dated October 21.

"We received our ERIE Shovel during the month of May, have operated it continuously ever since, first for the purpose of grading and excavating for railroad tracks and later on for loading gravel.

"We are highly pleased with the shovel and believe it to be the best shovel that we have ever operated. It has a much longer and higher reach than the——— shovel. Whereas, we formerly owned two——shovels, which were satisfactory, we believe the ERIE Shovel far superior to the———and if we had to purchase a shovel today we would purchase none other. If you have use for a shovel you cannot make a mistake in purchasing the ERIE."

We do not purpose to gild the lily by adding anything to this advertisement beyond suggesting that now—**now**—is exactly the right time to investigate the Erie Revolving Shovel. Ask for our new Bulletin S-14 containing FACTS—FIGURES—PHOTOS, (mostly photos) you'll find it interesting.

ERIE REVOLVING SHOVEL



There are definite reasons for the superiority of the Erie Shovel. Here are a few of them:

Automatic Crowding Device—Controls Crowding Engines so you cannot cut below grade—unless you want to. Level floor bottom readily maintained. Shallow cuts efficiently handled.

Three Lever Cantrol—Just three levers and a foot brake to handle. Greatly simplifies operation of shovel. Enables operator to handle greater yardage.

Large Working Range—Cuts 35 feet wide on floor bottom. 50 feet wide at height of eight feet. Wagons can be loaded on top of an 8-ft. bank.

Sturdy, Accessible Construction—Erie Shovels are built for service. The operating mechanism is all accessible. Nothing "buried" or "hidden."

BALL ENGINE COMPANY, ERIE, PA.

Tanks, Automatic Sprinkler
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.

Tables and Boards, Drawing
Dietzgen Co., Eugene, Chicago, Ill.
Keuffel & Esser Co., New York. Hoboken, N. J.

Tanks and Towers
American Bridge Co., 30 Church St., N. Y. City.
Baltimore Cooperage Co., The, Baltimore, Md. Cable Address: Tanktowers, W. U. Code. Wooden and metal tanks, steel towers. All sizes for water, acids, chemicals, etc.
Blaw Steel Construction Co., Pittsburgh, Penn.
Chicago Bridge & Iron Works, Chicago, Ill.
Coatesville Boiler Works, 30 Church St., N. Y. C.
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.
Struthers-Wells Co., Warren, Penn.
Tippett & Wood, Phillipsburg, N. J.
Walsh's Holyoke Steam Boiler Works, Holyoke, Mass.

Tanks, Wood
National Tank & Pipe Co., Portland, Oregon.
Pacific Tank & Pipe Co., 5th and Bryant St., San Francisco.
Portland Wood Pipe Co., Portland, Oregon.
Redwood Manufacturers Co., 1605 Hobart Bldg., San Francisco, Calif.
Washington Pipe & Foundry Co., 1512-1620 Center St. and 3001-3019 Asotin St., Tacoma, Wash. Cable: Wash Pipe.

Tapes, Steel and Metallic
Aloe Co., A. S., 617 Olive St., St. Louis, Mo.
Dietzgen Co., Eugene, Chicago, Ill.
Keuffel & Esser Co., New York. Hoboken, N. J.
Lufkin Rule Co., Saginaw, Mich. N. Y. City;

Test Boring
Sullivan Mach. Co., 122 S. Mich. Ave., Chicago.

Ties, Steel
American Bridge Co., 30 Church St., N. Y. City.

Ties, Treated Wood
Berlin Mills Co., Portland, Maine.

Timber (Treated)
Berlin Mills Co., Portland, Maine.
Eppinger & Russell Co., 165 Broadway, New York.

Tools, Pneumatic
Chicago Pneumatic Tool Co., Chicago, Ill.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York City.

Tracing Cloth
Hardtmuth, L. & C., 34 E. 23rd St., N. Y. City. "Kohinoor" brand.

Tramways
American Steel & Wire Co., Chicago, Ill.
Waterbury Co., The, 63 Park Row, New York.

Transmission Towers, Galvanized
American Bridge Co., 30 Church St., New York.
Blaw Steel Construction Co., Pittsburgh, Penn.

Trenching Machinery
Austin Drainage Excavator Co., F. C., Railway Exchange Bldg., Chicago, Ill.
Ball Engine Co., Erie, Penn.
Carson Trench Mach. Co., Boston, Mass.
Erie Steam Shovel Co., Erie, Penn.
Marion Steam Shovel Co., Station M, Marion, O.
Parsons Co., Newton, Ia. 50 Church St., N. Y. C.

Turbines, Steam
Alberger Pump & Condenser Co., New York City.

Turbines, Water
Leffel & Co., James, Springfield, Ohio.

Card lists of Equipment are hard to keep. they won't correct themselves. this list will

Turnbuckles
American Bridge Co., 30 Church St., New York.

Turntables
American Bridge Co., 30 Church St., New York.
Pennsylvania Steel Co., Steelton, Penn.
Whiting Foundry Equipment Co., Harvey, Ill.

Turpentine
Berlin Mills Co., Portland, Maine.

Underpinning
Underpinning & Foundation Co., 290 Bway., N. Y.

Valves, Altitude
Simplex Valve & Meter Co., Philadelphia, Penn.

Valves, Automatic Air
Simplex Valve & Meter Co., Philadelphia, Penn.

Valves, Water, Steam, Gas
Coldwell-Wilcox Co., Newburgh, N. Y.
Darling Pump & Mfg. Co., Williamsport, Penn.
Eddy Valve Co., Waterford, N. Y.
Golden-Anderson Valve Specialty Co., 1202 Fulton Bldg., Pittsburgh, Penn. "Controlling Altitude"—automatically maintain uniform water level in tanks, etc. "Water Regulating"—control a reduced pressure regardless of initial volume. "Triple Acting Non-Return"—for automatically protecting boilers and steam lines. "Float Valves" for maintaining water.
Norwood Engrg. Co., Florence, Mass.
Rensselaer Valve Co., Troy, N. Y.
Southwark Fdry. & Mach. Co., Philadelphia, Pa

Ventilating Apparatus
American Blower Co., Detroit, Mich.
Lupton's Sons Co., David, Westmoreland and Tulip Sts., Philadelphia, Penn.

Wagon Loaders
Haiss Mfg. Co., 142nd St. and Rider Ave., N. Y. C.

Wagons, Dump
Austin Mfg. Co., Chicago, Ill.
Western Wheeled Scraper Co., Aurora, Ill.

Water, Stage Recorders
Leupold & Voelpel, Portland, Oregon.

Waterproofing
Barrett Mfg. Co., New York City.
Carey Co., Philip, 18 Wayne Ave., Lockland, Ohio.
Johns-Manville Co., H. W., New York City, N. Y.

Well Drillers
Phillips & Worthington, 90 West St., N. Y. City.

Well Drilling Machines
American Well Works, The, Aurora, Ill.
Keystone Driller Co., Beaver Falls, Penn.

Winches
Lidgerwood Mfg. Co., 96 Liberty St., N. Y. City.

Window Sash, Steel
Lupton's Sons Co., David, Westmoreland and Tulip Sts., Philadelphia, Penn.
Trussed Concrete Steel Co., Dept. 12, Youngstown, Ohio. Representatives in principal cities. "United" steel sash; horizontally and vertically pivoted sash. Counterbalanced and counterweighted sliding sash. Center pivoted and top hung continuous sash. Steel and glass partitions, sliding and swing doors. Casement sash.

Wire Clips
Marion Malleable Iron Works, Marion, Ind.

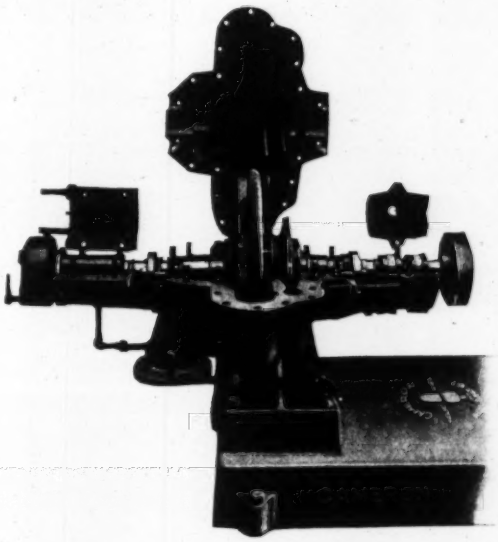
Wood Preserving
Barber Asphalt Paving Co., Maurer, N. J.
Barrett Mfg. Co., New York City, N. Y.
Carbolineum Wood Preserving Co., 181 Franklin St., New York City, N. Y.
International Creosoting & Construction Co., Galveston, Tex.
Northeastern Co., The, Boston, Mass.
Pittsburgh Wood Preserving Co., Pittsburgh, Pa.

IF YOU are in the market for any class of machinery or equipment which you cannot find in the Buying Section, Engineering News will have your wants published free of cost and thus put you in touch with the right manufacturer or dealer.

Business News Department

The Slogan of the Cameron—"Character: the Grandest Thing"

In Long, Steady, Unbroken Pumping



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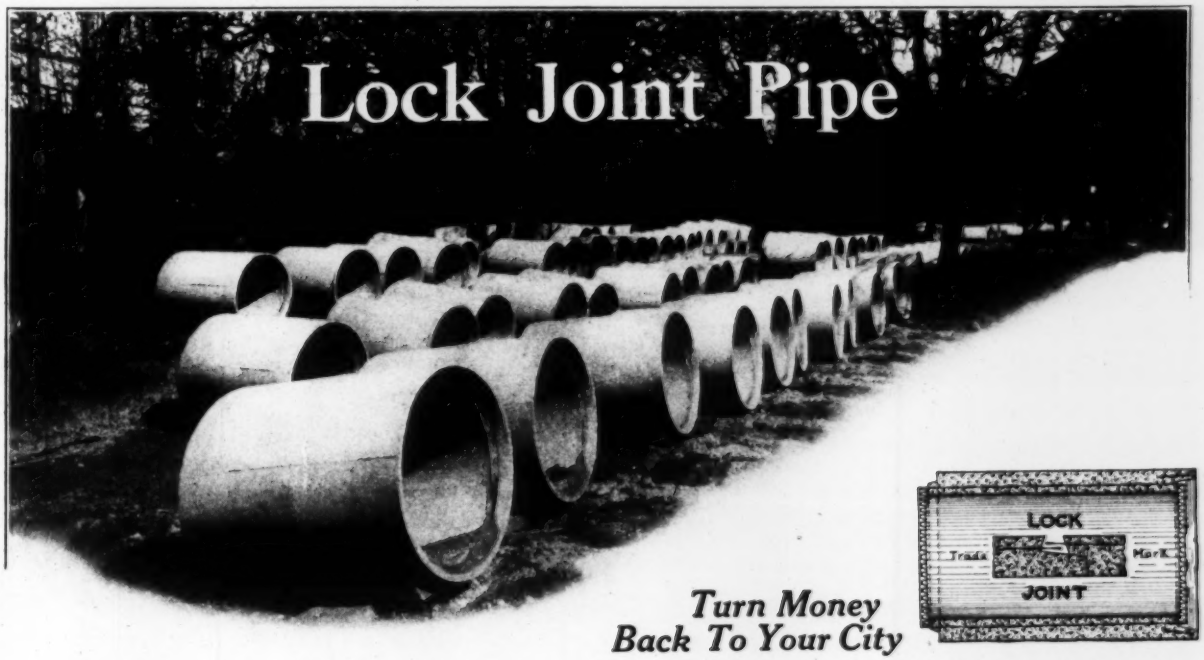

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ALPHABETICAL INDEX TO ADVERTISERS

Page

Aetna Explosives Co., Inc.. 56
Ainsworth & Sons, Wm.... 62
Alberger Heater Co..... 39
Alberger Pump & Condenser Co..... 41
Aloe Co., A. S..... 64
Alpha Portland Cement Co.. 8
American Blower Co..... 42
American Bridge Co..... 61
American Cast Iron Pipe Co. 44
American Creosote Works. 55
American Gas Furnace Co. 44
American Metal Hose Co... 49
American Pipe & Construction Co..... 44
American Sheet & Tin Plate Co..... 42
American Steel & Wire Co. 54
American Water Softener Co..... 47
American Well Works, The 3d cover
Astoria Light, Heat & Power Co..... 38
Atlas Portland Cement Co. 56
Austin Drainage Excavator Co., F. C..... 52
Austin Mfg. Co..... 50

Babcock & Wilcox Co., The 43
Bacon, Earle C..... 50
Ball Engine Co..... 77
Barber Asphalt Paving Co. (Maurer)..... 55
Barrett Mfg. Co. 4th cover, 55
Bartlett & Snow Co., C. O. 42
Bausch & Lomb Optical Co. 63
Belmont Iron Works..... 61
Bergen & Lindeman, Inc... 44
Berger & Sons, C. L..... 63
Berger Mfg. Co., The..... 57
Berlin Construction Co.... 59
Berlin Mills Co..... 55
Blake & Knowles Steam Pump Works 41
Blaw Steel Construction Co. 39, 60
Bond Co., Harold L..... 40
Boston & Lockport Block Co. 60
Bowers Co., S. P..... 55
Browning Co., The..... 11
Buchanan Co., C. G., Inc... 51
Buff & Buff Mfg. Co..... 63
Buffalo Steam Roller Co... 50
Builders Iron Foundry.... 47
Buyers' Cyclopedia..... 68

Cable Excavator Co..... 54
Cameron Steam Pump Works, A. S..... 79
Carbolineum Wood Preserving Co..... 55
Carey Co., Philip, The..... 51
Carson Trench Mach. Co.. 55
Case Crane & Engineering Co. 59
Central Foundry Co., The.. 45
Chicago Bridge & Iron Wks. 43
Chicago Pneumatic Tool Co. 51
Chicago Steel Tape Co.... 64
Clow & Sons, Jas. B..... 44
Coatesville Boiler Works.. 42
Coldwell-Wilcox Co..... 46
Consulting Engineers. 65, 66, 67
Cook, A. D. 39
Custodis Chimney Cons. Co., Alphons..... 44

Dake Engine Co..... 38
Darling Pump & Mfg. Co.. 42
Deane Steam Pump Plant.. 40
Des Moines Bridge & Iron Co. 43
Dexter Portland Cement Co. 54
Dietzgen Co., Eugene..... 62
Directory of Consulting Engineers..... 65, 66, 67
Donaldson Iron Co..... 44

Page

East Jersey Pipe Co..... 45
Eastern Bridge & Structural Co..... 59
Economy Drawing Table Co. 64
Eddy Valve Co..... 48
Edson Mfg. Co..... 40
Eppinger & Russell Co.... 55
Erie Steam Shovel Co..... 77

Fairbanks, Morse & Co.... 41
Flory Mfg. Co., S..... 52
Foote Concrete Machinery Co. 51
For Sale Ads..... 36
Fort Pitt Bridge Works... 59
Fox & Co., John..... 48
Franklin Steel Works..... 57
French & Co., Samuel H... 56

Gillespie Co., T. A., The... 44
Glamorgan Pipe & Foundry Co. 44
Golden-Anderson Valve Specialty Co. 49
Goulds Mfg. Co., The..... 39
Gurley, W. & L. E..... 62

Haiss Mfg. Co., Inc., Geo.. 48
Hardtmuth, L. & C..... 62
Harris Air Pump Co..... 42
Hartranft Cement Co., Wm. G..... 54
Hayward Co., The..... 11
Heine Chimney Co., The... 41
Heinicke, H. R., Inc..... 43
Hersey Mfg. Co..... 48
Higgins & Co., Chas. M.... 64
Hinman Hydraulic Mfg. Co.. 48
Hydraulic Pressed Steel Co. 57

Improved Equipment Co... 42
Independent Pneumatic Tool Co..... 50
Industrial Works..... 53
Ingersoll-Rand Co..... 75
Insley Mfg. Co..... 14
Inspecting Engineers..... 67
International Creosoting & Construction Co..... 55
International Steam Pump Co. 39, 40, 41

Jeffrey Mfg. Co., The..... 52
Jennison-Wright Co., The. 69
Johns-Manville Co., H. W.. 59

Kellogg Co., M. W., The... 44
Kenwood Bridge Co..... 59
Keuffel & Esser Co..... 62
Keystone Driller & Pump Co. 40
Kinnear Mfg. Co., The..... 60
Kittoe Boiler & Tank Co... 45
Kolesch & Co..... 63

Lackawanna Bridge Co., 60
Lackawanna Steel Co. 2d cover
Laclede Steel Co..... 60
Lawrence Cement Co., The. 56
Lawrence Machine Co..... 42
Lawrence Pump & Engine Co., The..... 41
Leadite Co., Inc., The..... 47
Leffel & Co., James..... 42
Lehigh Portland Cement Co. 71
Lidgerwood Mfg. Co..... 53
Link-Belt Co..... 54
Lock Joint Pipe Co..... 79
Lufkin Rule Co., The..... 64
Lupton's Sons Co., David... 16

Page

Lynchburg Foundry Co.... 44

MacArthur Concrete Pile & Foundation Co..... 56
MacKinnon-Holmes & Co.. 59
Marion Malleable Iron Wks. 46
Marion Steam Shovel Co., 51
Massillon Iron & Steel Co.. 44
Maurer & Son, Henry..... 58
McClintic-Marshall Co..... 61
McConway & Torley Co... 49
McGowan Co., John H..... 39
McGraw-Hill Book Co., Inc. 13
McKiernan-Terry Drill Co. 52
McKim Foundry & Machine Co. 48
McNeil & Bro., James..... 44
Metaline Co., The..... 54
Michigan Pipe Co., The... 46
Milwaukee Bridge Co..... 60
Minneapolis Steel & Machinery Co. 60
Missouri Valley Bridge & Iron Co. 60
Morava Construction Co... 58
Morris Machine Works..... 7
Morse & Son, Inc., A. J... 56
Mount Vernon Bridge Co.. 59

National Hoisting Engine Co. 53
National Lead Co..... 58
National Meter Co..... 49
National Tank & Pipe Co.. 46
National Tube Co. 45, 46
Nazareth Cement Co..... 56
New England Column Clamp Co. 59
N. Y. Continental Jewell Filtration Co..... 48
Norfolk Creosoting Co..... 55
Northeastern Co., The.... 55
Northern Engr. Works.... 52
Norwalk Iron Works Co... 54
Norwood Engineering Co.. 48

Ohio Locomotive Crane Co. 53
Orton & Steinbrenner Co... 54
Owen Bucket Co., The.... 54

Pacific Coast Pipe Co..... 44
Pacific Tank & Pipe Co.... 46
Page Woven Wire Fence Co. 59
Paragon Machine Co..... 64
Parker, A. A..... 42
Parsons Co., The..... 55
Patterson-Sargent Co., The 58
Penn Bridge Co..... 60
Pennsylvania Flexible Metallic Tubing Co..... 50
Pennsylvania Steel Co., The 61
Phoenix Bridge Co., The.. 60
Pitometer Co., The..... 48
Pittsburgh Block & Mfg. Co. 60
Pittsburgh-Des Moines Steel Co..... 43
Pittsburgh Filter Mfg. Co.. 47
Pittsburgh Meter Co..... 47
Pittsburgh Wood Preserving Co. 55
Portland Wood Pipe Co... 46
Positions Open & Wanted, 37
Power Specialty Co..... 42
Proposals 33, 34, 35
Pulsometer Steam Pump Co. 15

Rail Joint Co., The..... 50
Ramapo Iron Works..... 51
Ransome Concrete Machinery Co. 10
Raymond Bros. Impact Pulverizer Co. 48
Raymond Concrete Pile Co. 3

Page

Rensselaer Valve Co..... 47
Richardson, A. S..... 38
Ritchie & Sons, E. S..... 62
Riter-Conley Mfg. Co..... 59
Riverside Bridge Co..... 60
Roberts Filter Mfg. Co..... 47
Robins Conveying Belt Co., 49

Scherzer Rolling Lift Bridge Co..... 60
Schools and Colleges..... 67
Second-Hand Equipment... 33
Sessions Foundry Co., The. 54
Shoemaker & Co., Lewis F. 61
Simplex Concrete Piling Co. 59
Simplex Valve & Meter Co. 47
Smith Co., The T. L..... 73
Smooth-On Mfg. Co..... 6
Snare & Triest Co., The... 58
Snead Architectural Iron Works 62
Southwark Foundry & Machine Co. 12
Standard Cast Iron Pipe & Foundry Co. 44
Standard Oil Co..... 71
Standard Wood Pipe Co... 46
Strauss Bascule Bridge Co. 60
Strobel Steel Construction Co. 60
Struthers-Wells Co..... 46
Sullivan Machinery Co.... 50

Terry & Tench Co., Inc., The 52
Testing Engineers..... 67
Thew Automatic Shovel Co. 52
Thomson Meter Co..... 47
Tippett & Wood..... 43
Trussed Concrete Steel Co. 4, 5

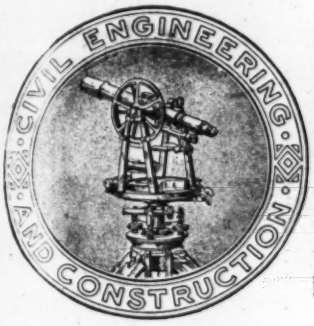
Underpinning & Foundation Co. 60
Union Iron Works..... 58
U. S. Cast Iron Pipe & Foundry Co..... 44
Universal Drafting Machine Co. 63

Variety Iron & Steel Works Co., The 56
Vulcan Iron Works..... 41

Walsh's Holyoke Steam Boiler Works..... 46
Want Ads..... 36
Warren Foundry & Machine Co. 44
Washington Pipe & Foundry Co. 46
Waterbury Co., The..... 52
Weber Chimney Co., The.. 43
Webster Mfg. Co., The.... 50
Weiss Instrument Co., The 63
Western Wheeled Scraper Co. 42
Westinghouse Air Brake Co. 40
Whiting Foundry Equipment Co. 53
Wicks Bros. Co..... 64
Wiederholdt Construction Co. 43
Wiley & Sons, John, Inc.... 9
Williams, Brown & Earle. 62
Wisconsin Bridge & Iron Co. 56
Wood & Co., R. D..... 45
Worthington, Henry R..... 39
Wyckoff & Son Co., A..... 47
Wyckoff Pipe & Creosoting Co. 55
Wyoming Shovel Works... 73

Youngstown Iron & Steel Co., The..... 59

VOL. 76 No. 2



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July 13, 1916
Two Sections—Section No. 2

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ISSUED WEEKLY

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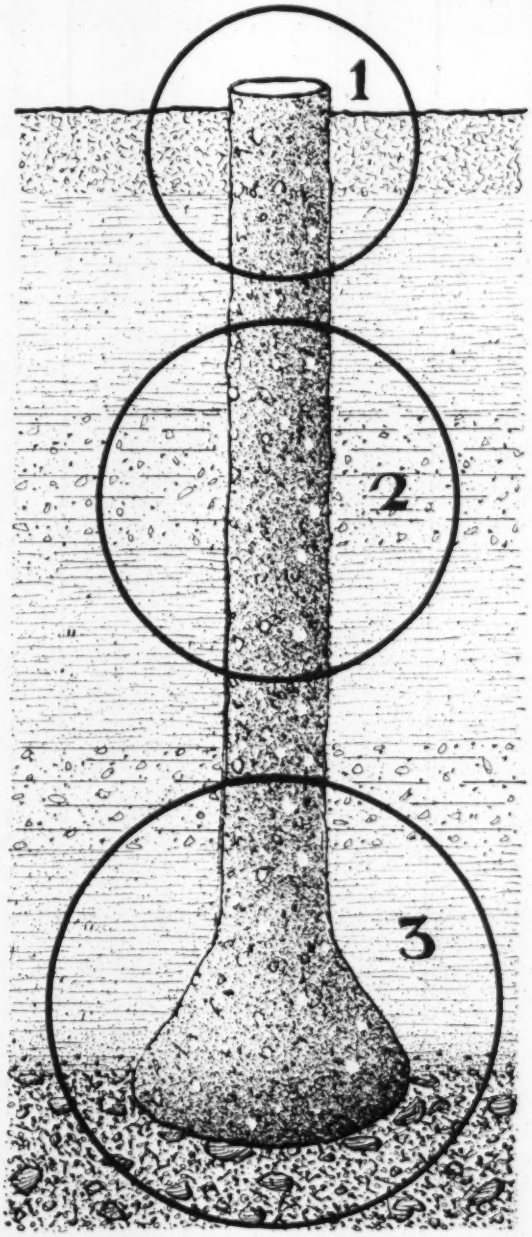
How Treacherous Soils are Conquered by PEDESTAL PILES



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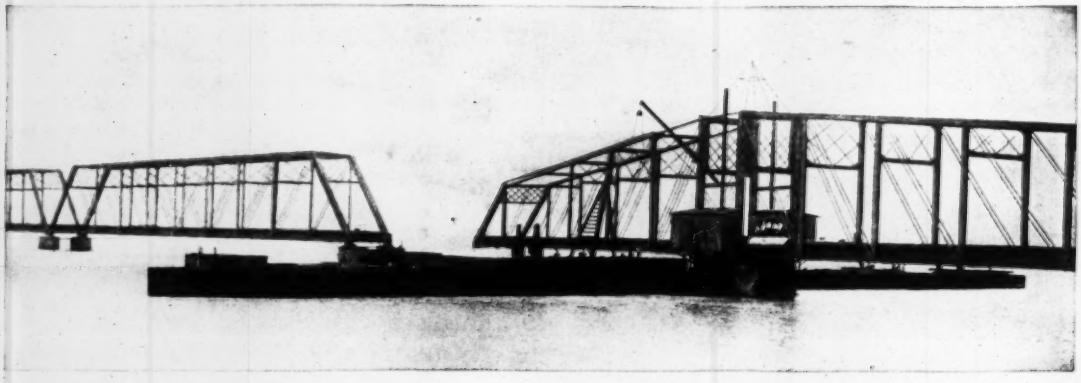

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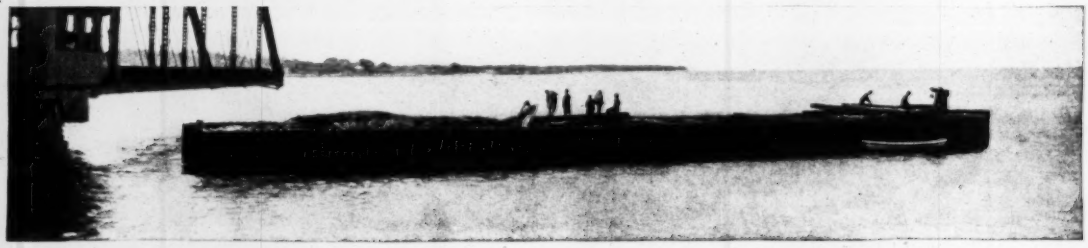

220

ENGINEERING NEWS

INDEX TO VOLUME LXXV

January 1 to June 30, 1916

Subdivided into GENERAL (including AUTHORS,) ENGINEERING LITERATURE AND CONTRACT PRICES

Explanatory Note

This index follows, generally, the methods adopted, and more fully explained with the index for Volume 71. An asterisk (*) indicates an illustrated article and (n), (ns), note, notes. As such are designated the articles under "Appliances and Materials" and some of the briefer ones under "News of the Engineering World," although in large type. Letters are not distinctively specified, nor are editorials usually. An editorial referring to an article may be indexed by appending the page number.

Following is a list of the pages included in the several numbers of this volume, by date:

Jan.	6	pages	1-48
"	13	"	49-96
"	20	"	97-144
"	27	"	145-200
Feb.	3	"	201-248
"	10	"	249-296
"	17	"	297-344
"	24	"	345-392
March	2	"	393-440
"	9	"	441-488
"	16	"	489-536
"	23	"	537-584
"	30	"	585-632
April	6	"	633-680
"	13	"	681-728
"	20	"	729-776
"	27	"	777-824
May	4	"	825-872
"	11	"	873-920
"	18	"	921-968
"	25	"	969-1016
June	1	"	1017-1064
"	8	"	1065-1112
"	15	"	1113-1160
"	22	"	1161-1208
"	29	"	1209-1256

A

Aberdeen, Wash. — Water supply *603, (ns) 341, 869, 1011
Abilene, Kan.—City manager's experience 379, Sewage-pumping station and traffic signal post *565
Abney level, Special. Bonner.....*25, 37
Abutments, Standard concrete, for Mich. highway bridges; perspective drawings. Dewart *738, 809

ACCIDENTS

See also "Fire," "Flood," "Storm," "Earthquakes," "Earthslides."

—Blast wrecks restaurant, Akron.....(n) 1013
—Bridge abutments undermined by high water, Alpena, Mich.....*724
—Bridge broken by traction engine.....*299
—Bridge damaged, Tonawanda flood.....(n) 869
—Bridge failure, Spokane *92, 135, (ns) 197, 534, 630, Seaman 38, Miller 87, Cunningham 133, Norton 333, Yates..... 431
—Bridge falsework washed out, Memphis *43, (ns) 197, 725, Kan. Cy.....196, *245
—Bridge, Ill. highway—Ruptured stirrup drops floor 1091
—Bridge, Rusted pony-truss, Johnstown, Penn., collapses *622, 817
—Bridge, Three-hinged concrete, San Diego, fails by undermining.....*292
—Bridge, Tugboat shifts draw-, Milton, Ala. .....(n) 1205
—Bridge washout, Athens, Penn..... 719
—Building collapse, Rockford, Ill.—Frozen concrete .....(n) 294
—Building—Long-span Howe trusses fail under snow, of skating rink, Salt Lake Cy. *1184
—Canal, Welland, gate accident.....(n) 869
—Car fall, St. Louis sewer.....(n) 581
—Car, Side-dump, capsized.....(n) *712
—Compensation law, Typhoid an accident under 426
—Concrete roof failure Memphis..... 579
—Dam failure, Erie Canal 94, Repairs.....*1121
—Dam failure, Hatchtown. Sterling *56, Errata .....(n) 285
—Dam failure, Lower Otay, etc., San Diego, Calif. *236, 283, *334, *288, 462, 473, 717, 810, 909, *1006, 1060, (n) 293
—Dam failure, Plattsburg.....*1106, 1146
—Dam failure, Salt Riv. diversion.....*974
—Dam failure, So. Alberta.....*1070
—Dam, Seneca Falls, repaired.....*500
—Explosion, contractor's magazine, St. Louis (n) 486
—Explosion on submarine..... 183
—Flood diversion ditch washout at Sioux Falls (n) 965, Yappen *1102

ACCIDENTS—Continued

—Garbage-reduction works explosion, Los Angeles .....(n) 869
—Gasoline-tank explosion, Balboa.....(n) 1254
—Grain-elevator explosion, P. R. R., Balto. (n) 1205
—Motor-vehicle accident statistics..... 234
—N. Y. Dept. of Labor bulletin—Safety for eyes, etc. 1193
—Railways:
B. & O. S. W. bridge accident, Deputy, Ind. .....(n) 869
Chi., Rock I. & Pac. bridge-washout wreck, Packard, Iowa 1195, *1200
Crossings, Reduce accidents at—A. R. A. report 1061
I. C. C. report for 1914.....(n) 773
Nashville, Chat. & St. L.—Wreck—Stray current worked signal relay.....(ns) 45, 341
N. Y. Cent. rear-end collision, Albany (ns) 486, 1156, Wreck, Amherst, O. (ns) 678, 917
N. Y. Elevated rear collision.....1194
N. Y., N. H. & H. rear-end collision, Milford 475, (n) 390, Rear-end collision, Bradford .....(n) 773
—Sewer explosion, Detroit gasoline.....*577
—Sewer failure, Cairo, Ill.....*565
—Sewer, Gasoline floods Pittsburgh.....(n) 581
—Shaft, Boston Tunnel—Men killed.....(n) 1254
—Tower, Lighting, fails, San José.....*279
—Trestle, Steel, bent fell, Bessemer & L. E. R. R. .....(n) 917
—Tunnel blowout, East Riv., N. Y.....(n) 390
—Viaduct failure, Penistone, Eng...(ns) 486, 1129
—Water-conduit break, Concrete, Victoria 571, (n) 580
—Water-main breaks, Boston.....(ns) 486, 1254
—Wharf, Coal, collapse, Portland, Me...(n) 1205
—Wood water pipe, Seattle, fails 140, 184, 233, 571, (n) 197, Ober *242, Fowler *587, Lamb 647, Partridge.....911, 907
Accounting, Depreciation, Pick rational plant units for. Klotz 23, Sinking-fund delusion. Humphreys 187
Accounting, Public-works, for villages and towns—Hanover, N. H. Holden.....*1082
Accounting system, Uniform, Wis. Tax Comm. (n) 837
Acetylene flare lamps, Carbic.....(n) 96
Acid-resisting alloy, Parr's.....(n) 344
Acoustic properties, Building. Clevens..... 817
Acre, Table for sq. ft. into decimals of. Gerber .....(n) 232
Acres, Area in—Rule. Gibson.....(n) 34
Activated-sludge status, Brooklyn, Baltimore, Milwaukee, Chicago, Cleveland. Hammond *798, Erratum 911, Problems. Ed..... 809
Activated sludge, Chi. stockyards. Lederer 932, (n) 292
Activated-sludge experiments, Milwaukee. Hatton 262, 306, Definition.....(n) 503
Activated-sludge patents, Brit. and Am. Hatton 189
Activated-sludge unit trial, Cleveland. Pratt *671
Acton, R. W. Contract and day-labor road construction compared 644
Adams, T. Town planning, Can..... 991
Adding machine, Simplified, Mechanical Accountant Co.'s .....(n) 728
Adding machines for leveling parties.....(n) 904
Advertising—Letters of Self-Made Merchant. Hill 859
Advertising metered water service, Terre Haute (n) *664, San Antonio.....*1031, 1051
Aëration. See "Water pollution and purification," "Sewers."
Aërial coast patrol, Peary.....(n) 486
Aërial tramway. See "Cableway."
Aëroplane testing wind tunnel, Naval. McEntee *697
Africa—Trans-African Ry.....(n) 288
Air and gas sampler, Oberholser's.....(n) 711
Air—Applying mortar with cement gun, Elephant Butte 469, Lining Hawaiian ditches.. 950
Air—Cement-gun waterproofing of concrete tank *1044
Air—Coating steel at Grand Cent., N. Y., with cement gun. Jordan.....*1008
Air, Compressed, Calming rough water with, Brashear system *1166
Air compressor, Vertical gasoline-driven, Lyons Atlas .....(n) *440
Air—Concrete blowing plant, Susquehanna viaduct *538
Air—Concrete mixing and placing, Chi. water tunnel *969
Air—Concrete mixing and placing, N. Y. subway. Comstock *496
Air-hose winder. McDermid.....(n) *200
Air-lift pump, Quebec *112
Air rectifier prevents frozen brakes.....(n) 200
Air siphon, Cleaning large gas retorts with. McDermid *755

Air track tampers, etc. 515, 521, (correction 664,) 611
Air valve, Crane high.-pres.....(n) *872
Air wood-boring machine, Baird.....(n) *1256
Airey, J. Cross-sectioner.....*1092

Alabama—Water-power condemnation (n) 341, County road institutes.....(n) 1013
Alaska coal fields open.....(n) 1109
Alaska Gastineau tunnel heading, Shooting out 998
Alaska Ry. labor affairs.....(ns) 534, 917
Albany, N. Y.—Grit chamber and pump station, sewage works. Gregory....*1164, *1224
Alidade, Parallel-ruler, for plane-table. Bussell *175
Allen, K. Grease and fertilizer from city sewage 1005
Allison, J. C. New type of dam, Colo. River 1170
Allison, R. H. Ditching report form.....*707
Alloy, Acid-resisting, Parr's.....(n) 344
Alpena, Mich.—High water undermines bridge abutments. McNeil *724
Aluminum Co. of Am.—Concrete mixers for dam *676

Ambursen, N. F. Waterproofing concrete tank with cement gun *1044, Steel plate to make concrete tank water-tight.....*1103
American Asso. for Advancement of Science (n) 215
American Asso. of Engineers.....557, (n) 967
American Chemical Soc.....932, (n) 631
American Concrete Inst. 234, 379, 386, *496 (ns) 143, 568, 807
American Elec. Ry. Asso.....(n) 1000
American Electrochemical Soc. and A. I. E. E. water-power conference 677, 875
American Highway Asso. and Am. Road Builders' Asso.—Age (n) 134, Resolutions, meeting (n) 143, Bulletin on bonds..... 474
American Inst. Elec. Engineers—Pres. J. J. Carty. By C. W. Price *218, 220, Studying Institute's functions 340, Admission requirements 456, Electrolysis corrosion 595, Water-power conference 677, 875, Nationwide telephonic session 1011
American Inst. Mining Engineers—Pres. L. D. Ricketts. By P. C. Ricketts *218, *219, Admission requirements 456
American Iron & Steel Inst..... 83
American Ry. Asso.....1061, (n) 823
American Ry. Engineering Asso 625, *701, (n) 1050, Impact formula.....625, 1056
American Ry. Master Mechanics Asso.....1248
American Road Builders' Asso.—Pittsburgh meeting 482, Age (n) 134, Annual meeting (ns) 295, 1015, Resolution on bonds..... 475
American-Russian Chamber of Comm.....(n) 821
American Soc. Civil Engineers—Annual meeting 177, Highway sessions 178, May move headquarters 179, 244, Should headquarters be removed? 329, Deceiving the Society 570, The pending question—Col. Pickett's views 713, Phila. engineers favor house change 677, Union vs. identity. Trautwine 717, St. Louis engineers ask light on building 722, Discussing the change (n) 728, Admission requirements 456, Amending constitution 821, Vote for coöperation 1241, Discussion on local sections of societies 820, Ballot on discipline 1195, Sketch of Pres. Corthell. By D. FitzGerald *216, Coöperation suggestion. Dabney 1245, Column tests 183, *190, Lueder and Wilson on subway timbering 425, New type of dam, Colo. Riv. Allison 1170, Woman's membership suit (ns) 45, 341, San Francisco Asso. (n) 391, Summer convention plans (n) 1207, Death of Pres. Corthell 1001, Sketch of Pres. Herschel *1249, His address 1250, Summer convention report 1251
American Soc. H. & V. Engineers..... 618
American Soc. Mechanical Engineers—Pres. D. S. Jacobus. By W. Kent *218, 219, Admission requirements 456, New Orleans meeting 770
American Soc. Municipal Impvts.—Wood-block pavements *204, 433, 669
American Soc. Testing Materials—Grading yellow pine 368, *765, Fire-resistive construction 816
American Water-Wks. Asso.—Annual meeting 1150, Pres. Hill's address—Aims of the society 1152, Its steady progress 1145, Ill. sec. 267, 262, 306, 530, (n) 1062, N. Y. sec. paper 452
American Wood Preservers.....196, 869
Amsterdam—Paving cost .....(n) 807

Andrews, H. B. Measuring concrete aggregate *996

307621

Page

Ann Arbor, Mich.—Tarred concrete pavement. Osgood 352, 377, 764, Combined sidewalk, curb and storm sewer. Thomas.....(n) *1144
Ansonia, Conn.—Canal embankment blowout *1231
Applicant's difficulty, The. Fleming.....1088
Appraisal. See "Valuation," "Rates," "Interstate Commerce Comm.," "Public Service," "Tax," etc.

AQUEDUCTS

See also "Pipe," "Water" topics, etc.
—Brick conduit, To clean.....(n) 1199
—Catskill:
Ashokan bridge patent suit.....580, 1157
Copper lining 195
Filing correspondence. Fee..... 786
Hill View reservoir, Lining, with concrete and riprap. Tidd *1022
Kensico dam contractor's home-made plant. Smith .....*326, (n) *82
Meter policy, New.....657, 665, 1011
Water, More, for N. Y..... 435
—Los Angeles—Building irrigation system. Heinly 926, (n) 773, Aërial tramways on construction work *1236, Water not to be sold outside (n) 1158, Publication of report. Del Valle 1102, Its distribution 1130
—San Antonio steel aqueduct for sewer.....*880
—San Francisco—Diverting aqueduct during tunnel construction *129
—Victoria concrete conduit break....571, (n) 580
Arcade, N. Y.—Concrete curb and pavement. Doyle *459
Arch. See also "Bridges."
Arch bridge, Concrete, Susquehanna; collapsible steel centers.....*537, (n) 670
Arch bridge, Steel, Indianapolis.....*596
Arch bridge, 565-ft. span steel, St. John, N. B. *777
Arch centers lagged with sods, Ecuador. Howe *432
Arch, Pitt Riv., near Baird, Calif.—242-ft. concrete arch *1209, Difficult falsework erection *50
Arch, Concrete, reinforcement—Thacher patent suits 290, 580, 1157
Arch concreting, Top forms in. Watters (n) 34, Culverts *128
Arch, Hell Gate *66, 83, 185
Arch, Long steel—Old Trails bridge, Colo. Riv. *1040
Arch, Steel bridge, Colo. Riv. *672, Erratum .....(n) 817
Arch, Thrust of steel, adjusted by end jacking, Berlin street crossing. Kramer.....*372
Arch-truss roof, Chi. armory drill hall.....*152
Arch trusses, Erecting steel, Chi. municipal pier .....*999, (n) *424
Arch viaduct, Nickel-steel, Berlin.....*734
Arches, Concreting, Park Ave. viaduct, Cincinnati. Ruth *659, *936
Architecture, Wash. bridge, etc. *1, 36, Coöperation between engineer and architect. Johnston 285
Argentine business conditions..... 436
Arizona—Caliche roads *832, Bridge washouts in desert *873, State Engineer's office *1048
Arkansas River. See "Floods."
Armco Culvert Mfrs.' Asso.—Culvert tests.. 958
Armor-plate plant, Govt. 666, (n) 87, Estimating cost in it..... 857
Armory drill-hall roof, Chi.....*152
Army. See "War," "U. S."
Arrowrock dam work. Paul 62
Ash Fork steel dam.....*1035
Ashpit, Water-filled, A. R. E. A..... 627
Ashpit, Water-filled, on B. & O., Chicago *1085
Ashtabula, O.—City manager..... 233
Ashton, E. Hydrated lime in concrete..... 470
Asphalt plants, Portable, Warren.....(n) *968
Asphalts, etc., Howard & Morse automatic penetrometer for testing .....(n) 920
Assessments, U. S. Supreme Court on special, St. Louis 287
Associated Pipe Line Co.'s oil-fire fighting installation *794
Astoria, Ore.—Concrete viaduct vs. fill for street elevation *1176
Atlanta, Ga.—Incinerator suit .....(ns) 869, 1109
Atlantic Cy., N. J.—Draining quicksand for sewer .....(n) *1050
Auburn, N. Y.—Protecting water-supply (n) 1049
Auditoriums, Laws of sound in. Clevens... 817
Augusta, Ga.—Fire 953, 959, Building code (n) 772
Auckland, N. Z.—Concrete piles.....*1177
Austin, Tex.—More trouble at dam *636, (n) 1157, Enlarging creek flood channel *758, Still scarcity results in plain sewer concrete *903, Bedding cement-pipe sewers in lean concrete 996, Curb. inlet casting.....(n) *759
Australian engineers' union project....(n) 1157
Automobile. See also "Motor vehicles."
Automobile Club of Am. house management (n) 1206

B

Backfiller, Economy traveling.....*754
Backfiller, Parsons caterpillar, for bench work *898
Backfilling machine, One-man, Pawling & Harnischfeger *754
Backfilling washout, Salt Riv. Project (n) *808
Bacon, J. L. Dam failure.....239, 473
Bailey, E. A. Sacramento weir.....1204

Page

Bailey, F. S. Head-loss diagram for pipe bends *412
Baird, S. P. Specify formwork 613, Storing cement 1046
Baker, C. W. Otay dam failure.....*236
Baker, W. H. Brooklyn-Brighton viaduct...*489
Balcomb, J. C. Tunneling, Brazil *921, erratum .....(n) 1103
Baldwin, A. J., new pres.....*289
Baldwin, A. S. Credit for strengthening Cairo bridge 669
Ball bearings in endless tread, Tractor with—Good Roads Machy. Co.'s "Yuba Champion" *1119
Ballast, Gravel, tests, A. R. E. A.....(n) 1050
Ballast tamper. See "Tamper."
Ballasting track by contract, Mo. Pac.....*828

BALTIMORE, MD.

—Coal pier, B. & O.....*656, (n) 39
—Coal pier, P. R. R.....*399
—Cuban ores, Canton pier for.....(n) 1158
—Gas-lighting centennial, Public.....(n) 1254
—Loch Raven dam work.....*422
—Sewage, Grease from, Experiments.....1155
—Sewage treatment, Activated-sludge. Hammond *798, 809, 911
—Sewerage commission ended.....(n) 486
Bank of America Bldg. underpinning.....*681
Bank protection, Mo. Riv., above Sibley bridge, Santa Fe Ry.....*638, 665
Barge Canal. See "Canals."
Barge, Oil-driven steel, for river freight traffic *864, 858
Barge, State, of Mass. Tech.....*1203
Barleau, J. Irrigation module.....*806
Barker, H. Appraising water rights.....1179
Barker, J. M. To study strength of Burnettized timber *1084
Barnett, S. C. Coöperative schools..... 284
Barrel law, Standard dry.....(n) 870
Bartell, M. J. Calif. rainfall and runoff and recent floods 686
Bath, Me.—Water-wks. purchase. Fay..... 481
Bay of Fundy tidal power.....(n) 875
Bayonne, N. J.—Bush terminal.....(n) 917
Beams, Concrete, Spacing shear steel in. Beard *996
Beams, Continuous reinforced-concrete. Roark *354, *790
Beams, Heavy hooped-concrete, used in rebuilding theater, Wilmington. Smith *834, 857
Beams without lateral support. Fleming 648, Kercher 860
Beard, R. S. Spacing shear steel in concrete beams *996
Bearing, Slow-wearing dredge.....*836
Becker, R. W. Princeton water tanks.....*150
Belle Fourche reservoir, Height of waves in. Henny 1235
Belt-lacing hole templet, Southwick...(n) *1208
Benchmark, Concrete-capped pile.....(n) *81
Bender, Vise stand and, Martin.....(n) 296
Bennett, C. J. Calcium chloride for gravel roads 87
Bennett, R. Rock-fill dams.....463, 473
Bergen, Norway, fire.....(n) 341
Berlin, Germany—Jacking steel arch crossing *372, Nickel-steel arch viaduct.....*734
Bernhard, J. H.—River barge.....858, *864
Better Community Conference 1252
Bids. See "Contracts."
Bilderbeck, G. L. Will prosperity last?..... 575
Bilger, H. E. Old gravel and macadam for brick-pavement foundation 1223
Binghamton, N. Y.—Laying submerged water main *124
Birmingham, Ala., trolley-car concrete mixer *276
Bituminous binder, Quality of, as affecting wear. Pierce 1101, Road maintenance, N. Y. State 886, 907, (erratum n).....1103
Bitulithic. See "Pavements."
Black, Col. W. M.....*483
Blackburn, N. T. Galveston storm repairs..*393
Blake, E. M. Engineering soc. service..... 874
Blake, James, surveyor-poet.....1130
Blanchard, M. C. Railway-roadbed drainage *240

BLASTING

—Brazil—Driving Pirahy tunnel *921, erratum (n) 1103
—Coffer-dam blown up, Troy..... *42
—Explosive, Nonfreezing, Du Pont "Arctic" (n) 776
—Explosives hoist, Dangerous 445
—Forest fires, Checking, with dynamite. Lord (n) *616
—Halifax subaqueous blasting.....*228
—Ice, Freeing dredge from..... 174
—Log breaking with dynamite. Reedy...(n) 1246
—Norway, Large blast in.....(n) 280
—Powder hoist, Dangerous..... 445
—Railway construction, Halifax.....*188
—Restaurant wrecked, Akron .....(n) 1013
—Shaft sinking, Newport Mg. Co.'s.....*278
—Tool, Livingston's handy—Fuse cutter, etc. (n) 1049
—Tunnel, driving, Portchester sewage.....*374
—Tunnel, Shooting out Alaska Gastineau, under 150 ft. of water..... 998
—Well sinking, Dynamite helps, Hibbing.....*947
Blatch, Nora S., Lawsuit of.....(ns) 45, 341
Bligh, W. G. Irrigation headworks repair and dam failure.....*1070
Block system, Do elevated railways need?...1194

Page

Bloede scholarship .....(n) 870
Blower, Turbo, Ingersoll-Rand.....(n) 1111
Blue, R. Fed. Public Health Service as consulting engineers 1056, 1052
Blueprint paper going up.....(n) 376
Blueprint rack, Corner .....(n) *130
Blueprints, Black-line reproduction of—Rexim Co.'s "Eureka" process.....(n) 48
Boat. See also "Steamboat," "Submarine," "Ship."
Boat cargo weighed graphically. Ackerman (n) 1050, By displacement. Low.....(n) 1240
Boat, Gang drill, Halifax.....*228
Boat lines, Railway..... 35
Boat, Oil-driven steel, for river freight traffic—Inland Trans. Co.'s.....*864, 858
Boat—State barge of Mass. Tech.....*1203
Boats, Electrically propelled, N. Y. Barge Canal *98
Boats—Floating concrete plant.....*662
Boats, Marine railways for hauling, over dams *469
Boats, Shop, Tenn. Riv. plant repair. Burgess *173
Boiler plugs, Fusible, investigated by Bureau of Standards 351
Boiler rating, N. E. L. A. on.....1062
Bolt, Youngstown's hot. Oesterblom..... 87
Bolts, Track, Alloy-steel..... 206
Bond issues. See also places and objects.
Bonds, Long-term water-wks. Butcher *1036, 1051
Bonds, Serial, Advantages of..... 474
Bone's retaining-wall patent and its anticipations, etc. *254, 281, 331, 338, 429, 432, 478, 524, *572, 573, *813, (ns) 246, 868
Bonner, J. H. and F. E. Topographic surveys *24, 37
Books, Engineers' military 473, 506, Horton.. 669
Borden, H. P. Quebec bridge progress.... *20
Boring machine, Baird pneu. wood.....(n) *1256
Boston Civil Engineers' meeting 624, Papers, etc. 279, 304, 840, Dumer.....(n) 391

BOSTON, MASS.

—Belt freight railway proposed..... 770
—Boston Tech. See "Engineering schools—Mass."
—Charles River dam lock gates, Guarding, from galvanic action *210
—Chelsea north draw end lift.....*1216
—Engineers decapitated 184, 193, Mayor condemned 291
—Health and police depts. coöperation...(n) 937
—Semaphores not to be used.....(n) 1157
—Sewage, Grease and fertilizer base from; Miles treatment process. Weston 913, Allen 1005
—Sewer pumping-station piling. Dorr 127, 429, 813
—Subway escalator tests.....(n) 591
—Sudbury dam power.....*517, *544
—Tunnel work, Dorchester.....*136, 1046, 1198
—Wachusett dam foundation.....*1230
—Water tank, 2,500,000-gal. *109
—Water meters cut consumption.....1253
—Water-wks. bonds, Met.....*1036, 1051

Bowen, E. R. San Luis Rey floods.....*383
Bowie, C. P. Foam system for fighting oil fires *794
Bowlby, H. L. Columbia highway tunnel..*446
Bowles' oil-storage tanks.....*663
Box hunting, Breece dipping needle for..(n) 1256
Box, Packing, for exports.....(n) *280
Boyd, J. E. Spherical-segment problem.....*1228
Bradley, E. C. Why grouted brick pavement heaved 429
Brady, C. T., Jr. Impact formula.....1056
Brake, Thomas hoist safety *853, French & Allen device *1047
Brakes, National "air rectifier" prevents frozen .....(n) 200
Brands, Crosstie, B. & O.....(n) *328
Brandywine Shoal lighthouse. Rout.....*928
Brashear water-calming system.....*1166
Brazil—Opportunities and Brazil Ry. Lawrence *345, Rapid water-tunnel driving. Balcomb *921, (erratum n) 1103, Crossties (n) 206
Brehm, G. C. Brick and asphalt paving by day labor 1033
Brewer, I. C. Constant-flow device.....*1055
Brick. See also "Pavements," etc.
Brick, Bituminized paving, "Aspha-Bric"... 584
Brick production, Sand-lime.....(n) 759
Brick water conduit, To clean.....(n) 1199
Bricks from Hawaiian lava.....(n) 1031

BRIDGES

See also "Accidents," "Flood," "Viaduct."
—Abutment, Fractured, Rock Isl. Lines, Newton, Ia.....*1045
—Alpena, Mich., High water undermines bridge abutments. McNeil *724
—Ariz. bridge which does not collapse (n) *1000
—Atchison, T. & S. F. bridge, Olive, Calif. —Fishing for 60-ft. girders washed out in flood *1189
—Athens, Penn., steel-truss bridge over Susquehanna, Washout of..... 719
—Austin bridge and culvert.....*758
—Bascule-bridge end lock, Scherzer.....*395
—Bascule bridge, Erecting..... *29
—Bascule bridge, Lubricated trunnion pin for. Wiweke *803

Page

BRIDGES—Continued
—Bascule bridge, Short span, Ecorse Riv., Mich. *260
—Berlin, Germany—Thrust of steel arch adjusted by end jacking *372, Nickel-steel arch viaduct spanning 285 ft. *734
—Boston & Me. 4-span bridge, Deerfield River, rolled into place *840
—Cairo bridge over Ohio, Ill. Cent.'s, Strengthening *448, (Credit) Baldwin.. 669
—Calgary bridge controversy and Can. Soc. Civ. Eng. Porter 1148
—Causeway, Corpus Christi *628
—Ches. & O. Nor.—Bridge over Ohio at Sciotoville—Building concrete piers *418, Various work ..... *174, (n) 34
—Chi. bond issue for bridges ..... (n) 1110
—Chi., B. & Q. Metropolis and Kan. Cy. bridges—Silicon steel 1105, 1145
—Chi., Lake St. bascule bridge for elevated railway, in service *756
—Chi. track elevation, Ill. Cent., concrete and steel bridges *600, Columns *654
—Chinese palace bridge, Pekin—Bridge art at origin *40
—Cincinnati—Pile brooming, Runnymede Ave. bridge. Maxwell 126, Concreting piles, Hopple St. viaduct. Maxwell 614, Concreting arches, etc., Park Ave. viaduct. Ruth *659, Old iron viaduct. Ruth *936
—Cleveland—Brooklyn-Brighton concrete viaduct completed. Baker *489
—Colo. River, Needles long-span steel-arch bridge across *672, Erratum ..... (n) 817
—Columbia Riv. bridge earthwork approach. Howard *145
—Concrete bridges, Simple, for crossings over Mo. Pac. cut, St. Louis. Martin *408, Jefferson Ave. viaduct. Martin *1078
—Concrete girders—Continuous reinforcement. Roark *354, *790
—Concrete highway trestle across Yolo Bypass, Sacramento *358, 377, *854, 1205, Experience and costs in making the units. Holmes *825
—Concrete, Wet, pressure tests—Post of bridge, Danville, Ill. *935
—Crowds, Loads from moving 756
—Curved-bridge layouts, Short-chord calculation in. Swan ..... (n) *616
—Dayton bought concrete-bridge materials in advance 375, Bids 629, 715
—D., L. & W. flat-slab crossing, South Orange 521, *526
—Draw, New form of end lift used on Chelsea north, Boston. Gardner *1216
—Draw, Swiss bobtail. Rohn ..... (n) 153
—Floating bridge, Century-old, Lynn, Mass. *850
—Floor, Light wood, used on Cherry St. bridge, Toledo *543, Floating derrick (n) *176
—Flooring protection by snow ..... (n) 176
—Ft. Dodge, Des Moines & So. R. R.—Replacing Des Moines Riv. timber bridge with steel girder spans *994, erratum (n) 1103
—Gila bridge washout, Ariz. Eastern R. R. *792
—Harrisburg concrete bridge over Susquehanna *537, Arch centers ..... (n) 670
—Ill. highway—Ruptured stirrup drops bridge floor 1091
—Indianapolis 4-span steel-arch bridge *596
—Iowa highway bridges with I-beams and concrete deck, Illeman's, Boone County.. *1183
—Irrigation flume and highway, Double-deck bridge carrying, Sun River Project, Mont. 735
—Johnstown, Penn.—Rusted pony truss collapses. Chase, Godfrey *622, Beware of the dog! Trowbridge 817
—Kan. Cy. bridge falsework washed out. 196, *245
—Kan. country engineering; bridge destroyed by traction engine *299
—Los Angeles—Overdriven piles and poor subaqueous concrete *30
—Luten concrete patents discussion. Royse.. 185
—Memphis—Harahan bridge falsework washed out *43, (n) 197, Span closed ..... (n) 725
—Mex. railway bridge destruction *576
—Mich. highway bridges, Standard concrete abutments for; perspective drawings. Dewart *738, 809
—Military bridges, Lecture on 532
—Mississippi bridge, Keokuk, reconstruction—New spans on old piers *690
—Moving picture of lift bridge, Louisville & Portland Canal ..... (n) *904
—New Mex.—Highway-bridge record plans (n) 1240
—New Orleans—Bridge or tunnel to cross Miss. ..... (n) 1204
—N. Y. Conn. Ry.—Hell Gate arch; viaduct; Potter Ave. bridge, Astoria *66, 83, 185
—N. Y. highway bridges under scrutiny 533, (n) 285, Increasing loads and stresses.. 617
—Ohio Highway Dept.—Concrete-bridge railing details *855, Flat-slab standards... *947
—Old Trails bridge erection over Col. River—Long steel arch. Sourwine *1040
—Packard, Iowa, bridge washout wrecks train, Chi., Rock I. & Pac. 1195, *1200
—Parkersburg suspension bridge over Ohio opened *914
—Pasadena, Low bridge under high, Arroyo Seco *170
—Phila. park, Elaborate concrete bridge for *1248
—Philippines—Soil load tests 232
—Pier cylinders, Improvised lathe for. Goodday *611

Page

BRIDGES—Continued
—Piers, Building enduring 714
—Piers of cement and sand in bags, Sumatra. Swaren *1191
—Pine Bluff, Ark., vertical-lift span suspended by chains; "folding counterweight" *402
—Pitt Riv., Calif., near Baird—242-ft. concrete arch *1209, Difficult falsework erection *50
—Pittsburgh bridge-raising plans 290
—Pittsburgh 6th St. bridge-track repairs *612
—Potomac River bridge, New Aqueduct, Wash. 917
—Potomac bridge of Cumberland Val. Ry., Scrapping ..... (n) 1095
—Quebec bridge progress. Borden *20, Oil-quenching nickel-steel forgings. Yarnall *896
—Railing, Expansion bearing for concrete, St. Louis *1046
—Railway-bridge floor with old rails for outside guards, Atlanta & West Point and Western Ry. of Ala. *1095, Safe railway-bridge floors—Inside guards needed 1194
—Railway bridges, Wheel-load and impact charts for. Steinman *1173
—Railway steel-bridge impact formula—A. R. E. A. report. Turneaure 625, Brady... 1056
—St. John, N. B.—Two suspension bridges taken down *201, Steel-arch bridge, 565-ft. span, over Reversible Falls *777
—St. Paul ry. bridge plate girders ..... (n) 134
—San Diego 3-hinged concrete bridge fails by undermining *292
—Sibley bridge over Mo. Riv., A., T. & S. F.—Bank protection near it *638, 665, Raising embankment approach .... (n) *1096
—Spokane bridge failure *92, 135, (ns) 197, 534, 630, Seaman 38, Miller 87, "Fatigue" due to flaws; engineer's report to coroner. Cunningham 133, Norton 333, Yates 431
—Spoon River, Ill.—Old timber bridge and its modern successor with steel-truss and concrete spans *1155
—"Stress or strain." Seaman 284, Frankland ..... (n) 670
—Survey, Triangulation details for—Observing shelter; tripod target *327
—Suspension bridge, Students build, in 45 min., Wash. Univ. Bernard ..... (n) *760
—Thacher concrete bridge patent upheld 290, 580, 1157
—Tie spacer for floors, Q. & C. ..... (n) *1256
—Toll elimination, Del. Riv. ..... (n) 1206
—Toll schedule, Muscatine ..... (n) *130
—Trestles, Kan. Cy. So. *11, *203
—Utah road standards—Log truss for highway bridges *1238
—Washington, D. C.—Q Street ornamental concrete arch bridge over Rock Creek *1, Engineers and bridge art 36, Johnston 285
—Washington State — Long-span highway bridge ..... (n) 176
—Washouts in desert, Ariz. *873
—Waterbury, Conn., Combining bridge abutment with culvert. Harrison *172
—Youngstown's hot bolt. Oesterblom 87

Brightman, M. H. Town improvement records *470
Brinell-test outfit, Holz ..... (n) *920
British patents, activated sludge 189
British railways, Effect of Govt. control on 1228
British view of steel cars 475
Broan, J. M. Shaft sinking *278
Bronx planning—Zoning system *700
Bronze, Brinell compression hardness tests for, N. Y. Cent. 501, 521
Brooklyn-Brighton. See "Viaduct."
Brooklyn, N. Y. (see also "N. Y. City," "Subways")—Edison turbine foundation. Knight *28, *396, Activated sludge. Hammond *798, 809, 911
Brown, R. D. Industrial ry. turnouts *231
Browne window *951
Bucket, Bottom-dumping concrete *564
Bucket, Owen clamshell ..... (n) 776
Bucket, Small orange-peel, helps deep-well sinking, Hibbing *947
Buckets, Wheeled dump, Stuebner ..... (n) 392
Buckeye Traction Ditcher Co.'s large wheel-type excavator *1178
Bucyrus levee-building machine *989, 1004
Buffalo, N. Y.—Pumping station *207, Survey methods *466, Electric company's steam plant ..... (n) 534
Buffaloes, Bronze, Wash. bridge *3, 36, 285
Bug Run or N. Y. Cy. 763
Building Officials' Conference, Chi. (ns) 391, 488

BUILDINGS

See also "Concrete," "Floor," "Structural work," etc.
—Armory arch-truss roof, Chi. *152
—Augusta, Ga., to have code ..... (n) 772
—Cole Bldg., Nashville, Derrick tower to demolish ..... (n) *712
—Concrete building system, Peltzer's 880
—Dallas city engineering offices *698, 715
—Dayton conservancy headquarters *43
—Fire-resistive construction 761, Woolson.. 816
—Flooring, Temporary, in Penn. Lines' Chi. freighthouse during erection *898
—Frick Bldg.—Browne's window *951
—Highland Park Bank, Detroit, Erecting around older building *80
—Houses, Workmen's—Prize offer ... (ns) 390, 630

Page

BUILDINGS—Continued
—Howe tresses fail under snow *1184
—Lincoln Memorial, Wash., foundations *538, 613
—Lintel beams, Load from walls on. Perkins ..... (n) 759
—Mass. Inst. of Tech. buildings opened *1201, Pile tests *788
—Mill-construction buildings, Erecting, in winter—Timber frame ahead of brick walls—Central Bay Mfg. Co.'s *948
—Nashville fire-retarding zone ..... (n) 581
—N. Y. Cy. code published ..... (n) 772
—Pittsburgh—"Werder" and "Gazette-Times" buildings carried over ry. tunnel *1072
—R. R. and Bank Bldg., St. Paul ..... (n) 94
—Roof drainage, Conductor heads for. Wolf *901
—Roof, Waterproofing cures expansion that wrecks tile, U. S. Dept. Ag. laboratories *946
—St. Paul code revision ..... (n) 581
—Scaffolds, Cornice runways for swinging.. *851
—Shore, Adjustable, Roos' *78
—Sound-absorbing substance, "Amremoc" (n) 824
—Sound in auditoriums, Laws of. Clevens.. 817
—Theater, Cincinnati—Placing registers in concrete floor *375
—Theater, Wilmington, Concrete beams used in rebuilding. Smith *834, 857
—Wyman-Partridge factory and warehouse, Minneapolis—Concrete-mat foundation .. 1095
Bulkheads, Hydraulic-fill *145
Burdick, R. D. Engineering success 908
Bureaus, Govt. See "U. S." and cross-references.
Burgess, H. Shop boats *173
Burke's drainage-ditch design tables 1091
Burnettized timber, Mass. Tech. to study. Barker *1084
Burr, Prof. W. H., Columbia engineering alumni dinner to; his address 960
Burt, F. P., business manager ..... (n) 533
Burton, Senator, on Federal waterway methods 131
Bussell, C. T. Parallel-ruler alidade *175
Butcher, W. L. Public water-wks. financing *1036, 1051
Butler, N. M., on forests and rainfall 1053
Butte, Mont.—Steel and wood water mains.. 1108

C

Cable, Another transmission, under San Francisco Bay 719
Cable, Power, Swedish-Danish ..... (n) 645
Cableway—Derrick-trolley *175
Cableway—Straightening river, Dayton *64
Cableway system—Building dam *606
Cableways, etc. Levee-building *36, 1004
Cableways, Aërial, used on Los Angeles aqueduct *1236
Cableways, 3,800- and 4,200-ft., Champion Lumber Co.'s, N. C. *1057
Cahill, A. A. Subaqueous tunnel record 1046, 1198
Cairo, Ill.—Strengthening bridge *448, (Credit) Baldwin 669, Sewer failure *505
Caisson, Concrete, for Brandywine Shoal Lighthouse. Rout *928
Caisson, Concrete, pump pit, San Antonio.. *1127
Caisson sinking for tunnel shaft, Brooklyn.. *849
Calcium chloride for gravel roads. Bennett 87
Calcutta commercial museum ..... (n) 1000
Calgary, Alta.—Bridge controversy 1148
Caliche roads in Ariz. *832
Calif. Devel. Co. case ..... 170, (n) 390

CALIFORNIA

See also cities by name, "Bridges," etc.
—Eminent-domain decision ..... (n) 773
—Flood control, Los Angeles Co. *272, *310, Olmsted *314, 551, Lippincott 861
—Irrigation projects, Lindsay-Strathmore and Terra Bella ..... (n) 966
—Labor-camps cleanup, Rosenthal *1074
—Military-engineer reserve ..... 885, (n) 678
—Rainfall and runoff and recent floods. Bartell, McIntosh 686
—Roads, Bituminous-carpeted concrete 378
—Storms and floods 197, *236, 239, 283, *288, *292, *310, *334, *383, 461, 462, 473, 717, 810, 909, *1006, 1060, *1189, (n) 293
—Utility service rules adopted 105
—Water dispute, Cities' underground. Volk.. 12
—Water-wks. municipal-ownership ruling (n) 725
—Yolo Bypass viaduct *358, 377, *825, *854, Weir 1204
Cameron septic tank claims. Phelps 235, National Protective League 578
Camp, Railway, design competition, Natl. Americanization Comm.'s 819
Camps, Calif. labor, cleanup. Rosenthal... *1074
Canada—Montreal Polytechnique Alumni fix fees for engineering service 1183
Canada—Winnipeg Riv. hp. report *1104, Water-power administration, prairie provinces 1105
Canadian court upholds contractor 329
Canadian power development (see also "Water power")—Under arbitration 962
Canadian railways investigation ..... (n) 918
Canadian Soc. Engineers discusses reorganization 269, New president *339, (n) 479, Pavement and traffic reports 458, Traffic-graduation scheme 733, Calgary branch in bridge controversy 1148
Canadian town planning. Adams 991

Page

CANALS

See also "Irrigation," "Ditch," etc.
—Ansonia canal embankment blowout.....*1231
—Chi. drainage-canal supply limitation.....1108
—Cincinnati—Plan to use canal right-of-way for railway. Rew .....673, (ns) 578, 868
—Drainage canal deterioration. O'Brien..... 545
—Erie Canal dam failure, Tonawanda 94, Repairs—Concrete-capped sheet-pile dam. Low *1121, Weighing boat cargoes by displacement. Low .....(n) 1240
—Concrete lining irrigation canals, Machine for, Umatilla Project. Davis *264, Rio Grande Project *708
—Cylinder drops for canals, Rio Grande Project .....(n) *1144
—Irrigation canals, Location survey methods for, Grand Val. Project 997, Used before. Low 1199, Tile drainage for embankments .....(n) *1096
—Kutter's formula coefficients. Horton 373, 863, Ridenbaugh canal, Ida.; canal in Southern Calif. showing mass and mineral deposit. Scobey *862
—N. J. coast waterways.....(n) 438
—Marine railways for hauling boats over dams, Fox River, Ill.....*469
—N. Y. Barge Canal—How it will be operated. Yates—Electric barges; gate machines; valve machines; concrete lock cabins *97, Hydro-elec. and gasoline-elec. generating stations, concrete poles, etc. 158, Power developments. Horton 428, Contrast of new and old canals 135, Rescuing frozen dredge. Steere 174, Girder and truss weight formulas 422, Repair of break around Seneca Falls dam *500, Log conveyor. Reswick *552, Rebuilding at Irondequoit break. Low *646, Vote on bonds .....(n) 246
—Panama:
Concrete blocks in buildings.....(n) 270
Dredging records, Gaillard Cut.....(n) 664
Dry-dock—"Dapple" concrete finish 277, Completion .....(n) 966
Gasoline-tank explosion .....(n) 1254
Gatun dam foundation studies....*1229, *1232
Hospital interior wall finish..... 443
Hydro-elec. power cost.....(n) 191
Lock gates, McClintic-Marshall claims for extras on .....(n) 438
Locomotives, Towing by.....(ns) 89, 227
Railway boat-line law 35
Slide commission report.....532, 599
Slides, Experiments in checking. Goethals 417
Slides, Removing (ns) 246, 293, 580, 664, Canal reopened .....(n) 771
Towers, Darien radio. Carlson *546
Unprofitable business enterprise: A. P. C. 1054
Water hyacinth .....(n) 108
Water-supply under operating conditions. Kirkpatrick *782
—Sault Ste. Marie traffic.....(n) 831
—So. Alta. irrigation headworks repair and dam failure. Bligh.....*1070
—Tunnel, Marseilles Canal. Thompson 134, Not finished .....1156, (n) 917
—Welland headgates carried out.....(n) 869

Cantilever chimney base. Wise.....*572
Cantilever retaining walls. See "Patents."
Canton, Md.—Cuban ore pier.....(n) 1158
Canton, O.—Paving car track..... *77
Canvas inclosure, Light roof truss for. Chace *612
Capstan for hauling iron pipe across river *124
Capstan, N. Y. Barge Canal lock.....*102
Capstan plows, Glencoe ditching *226, Fisk's machine *615
Car, Dump, Coal-shipping.....*416
Car, Side-dump, capsized.....(n) *712
Car, Self-propelled dump, Orenstein-Arthur Koppel .....(n) *1112
Car-truck frames, Unit stresses in design of, Pressed Steel Car Co.'s.....1185
Cards, Filing. See "Filing."
Carey, J. D. Is development invention?.....*813
Cargo weighed graphically.....(ns) 1050, 1240
Carload, Largest—Generator.....(n) 725
Carlson, C. A. Darien radio towers.....*546
Carnegie Foundation investigation. See "Education—Engineers' qualifications."
Carnegie Steel Co.'s tests of high-sulphur steel 363, Handbook thumb index.....(n) *904
Carpenter, W. T. Creative imagination in engineering education 704
Carr, O. E. New profession..... 627
Cars, Concrete plant handled on four freight *1238
Cars, Cranes handle drop-bottom, Chi. park work *658
Cars, Freight, for autos.....(n) 613
Cars, Side-dumping gondola, Ralston....(n) *632
Cars, Small dump, on Rock Isl. concreting trains, Chi. *1188
Cars, Steel passenger, from British viewpoint 475
Cars, Utilizing material from old freight, B. & O. R. R.....(n) 1171
Cart, Grout, with paddles, Jaeger Mach. Co.'s "Turner" .....(n) *728
Cart, Newman side-dump, for backfilling...*126
Cart, Screen, for broken stone, Briggs-Chicago *852
Carter, F. H. Cement-testing cost 471, Erratum .....(n) 817
Carty, Pres. J. J. By C. W. Price.....*218, 220

Page

Cast iron. See "Iron and steel."
Catalogs made useful. Taglogs..... 479
Catchbasin-inlet protectors, Galveston..(n) *1192
Catenary section, Design charts for open flumes with. Robinson.....*566
Caterpillar backfiller for trench work.....*898
Caterpillar tractor, Ball-bearing.....*1119
Caterpillar tractor for ditching.....*227
Caterpillars, Osgood shovel with.....*995
Catskill Aqueduct. See "Aqueducts."
Causeway, Corpus Christi.....*628
Causeway repair, etc., Galveston....*393, (n) *568
Cebu city planning. Hardman.....*882
Cedar Rapids, Ia.—River wall.....*588
Cement. See also "Concrete," "Pavements," "Grout."
Cement gun, Coating steel at Grand Cent. Terminal, with. Jordan *1008
Cement gun, Costs of applying mortar with, Elephant Butte dam 469, Lining ditches, Hawaii. Collins 950
Cement gun, Waterproofing concrete tank with. Ambursen *1044
Cement, How to store. Baird.....1046
Cement-lined water pipe.....*300
Cement, National, industry revival..... 905
Cement, Portland, production..... 193
Cement sheds, Canvas-covered.....*769
Cement Show, Chi.—Concrete tests..... 695
Cement testing cost. Carter 471, Erratum .....(n) 817
Census. See "U. S."
Centigrade thermometer bill..... 283
Central Bay Mfg. Co.'s building.....*948
Chace, C. B. Light roof truss.....*612
Chain-lift bridge, Pine Bluff.....*402
Chamberlain, M. E. Sidewalks in steep streets *413
Champion Lumber Co.'s cableways.....*1057
Chart. See also "Diagram."
Chart, Engineer's salary.....*500
Chart—New computer. Yu Wang.....*1120
Chart, Wind-pressure. Wrigley *327, Skelton & Co.'s .....(n) *952
Chartrand, G. Paving problems, Tex. and Mo. cities 1102
Charts, Design, for open flumes with catenary section. Robinson *566
Charts, Wheel-load and impact, for railway bridges. Steinman 1173
Chase, C. E. Bridge collapse.....*622
Chattanooga Steel Co..... 629
Check valve, Smolensky.....(n) *96
Check valves for pumping engine, Counterweighted, Peoria .....(n) 1240
Chelsea north draw, End lift on. Gardner..*1216
Chemical-engineering scholarships (ns) 870, 1013
Chemical prices, Water-wks. and war 523, Monfort 530
Chemicals, Constant-level orifice box for feeding. Gavett *785, Brewer.....*1055
Chesapeake & O. N. See "Railways."

CHICAGO, ILL.

—Armory drill-hall roof.....*152
—B. & O. water-filled ashpit.....*1085
—Bridge, Lake St. bascule, open.....*756
—Bridges, Bond issue for.....(n) 1110
—Drainage-canal supply limitation.....1108
—Engineers studying military science 719, Preparedness parade .....(n) 1157
—Flat-slab floor rulings compared with Pittsburgh's. Ferguson 910, 1244, Godfrey 1244, What load to spandrel beams. Lord 1245
—Flooring, Temporary, for steel buildings during erection *898
—Garbage-disposal work centralized 1242, ...(n) 1204
—Grant Park filling work.....*658
—Lighting extension, Municipal.....(n) 1109
—Municipal-pier erection—Steel-arch trusses *999, Safety netting.....*424
—Paving Van Buren St..... 172
—Railway-terminal problem .....(n) 449
—Rapid-transit investigation .....(n) 293
—Scaffolds, Safety—Bldg. rules.....*376
—Sewage treatment, Activated-sludge. Hammond *798, 809, 911, Stockyards plant, Lederer .....932, (n) 293
—Sewer trenching, Handling pipes and conduits in 562
—Sewers, Building relief and outlet necessitated by new Union Station *212, Sewer and street work for same.....*948
—Shop plant, Municipal. Saner.....*1017
—Street widening 561
—Track-elevation bridges, Ill. Cent.....*600, *654
—Track elevation, Nickel Plate.....*370, 995
—Track elevation, Rock Isl.....*1188
—Typhoid from Lake Mich.....(n) 486
—Water tunnel, New *969, Steel shell 937, Steel-lined shaft *1237
—Water tunnels, Plugging old. Smith.....*706
Chilean nitrate industry. Cuevas 44
Chimney foundation, Difficult, tested after completion, Pittsburgh Brilliant pumping station *1138
Chimney, Old brick, with cantilever base. Wise *572
Chinese palace bridge *40, Railway progress. Koo 553
Chiriqui National R. R.....(ns) 69, 1158
Chute, Tests of concrete distributed by short, by comm. for Natl. Conference on Concrete Road Bldg. 802, "Spouting" or "chuting"? Spouter 1100
Chutes, Coal, Perry plant.....*737

Page

CINCINNATI, O.

—Bridge-construction features, Park Ave. concrete. Ruth *659, Old iron viaduct. Ruth *936
—Bridge-pile brooming, Runnymede Ave. viaduct. Maxwell 126
—Concreting piles with tremie, Hopple St. viaduct. Maxwell 614
—Interurban entrance and rapid-transit plan. Rew 673
—Rapid-transit plan .....(ns) 578, 868
—Water waste, negro tenements.....(n) 1062
Circuit-breaker, Automatic Reclosing Circuit Breaker Co.'s .....(n) 824
City. See also "Municipal," etc.
City charter, Model, Natl. utility-franchise policy for 209
City engineer wanted, Ottawa..... 629
City engineering offices, Dallas.....*698, 715
City government, Commission, abandoned, Denver .....(n) 1158
City improvement records kept in card index, Elgin, Ill. Brightman.....*470
City-manager govt., Phoenix, Ariz., undergoes test 1019
City manager—New profession. Carr..... 627
City manager, Reporter for, Ashtabula, O... 233
City-manager plan, 75 municipalities adopting 41
City manager, Tucson, Railway engineer's experience as 763
City manager's experience, Abilene, Kans.... 379

CITY PLANNING

—Automobiles, motor trucks and city planning. Lewis 1162
—Bronx zoning system, N. Y.....*700
—Canada, Town planning in. Adams..... 991
—Cebu, Philippines. Hardman.....*882
—Chicago street widening..... 561
—Cleveland, City Planning Conference.....1162
—National conference, Cleveland..... 823
—Natl. Municipal League's model city-planning board 19, 37
—N. Y. Cy.—Merchants turn planners; clothing mfr. restriction 523
—Okla. Cy.—Crazy planning.....*499
—San Francisco's civic center.....*1222
—Seattle—Dimock on expert advice..... 618
—Utica block street numbering.....*563
—Water mains and fire hydrants.....(n) 1062
Civic center, San Francisco.....*1222
Civil engineers. See "American Soc.," "Engineers," etc.
Civil service, N. Y. St.—Engineer positions standardized 654
Clabaugh, E. D. Fishing for girders washed out in flood.....*1189
Clamps for pulling steel piles, Vulcan...*472
Clamps, Form wire-tie—American (1) *632, Universal .....(n) *824
Clamps, Track bond-wire, P. & M. Co.'s (n) *664
Clark, A. T. Reservoir capacities..... 467
Clay-products exhibit, Permanent, San Antonio .....(n) *1096
Cleaner, Air-siphon. McDermid.....*755
Clearance diagram, New, A. R. E. A..... 625
Cleary, A. J. Reducing slippery pavements, San Francisco *608
Cleveland Engineering Soc.....(n) 1207

CLEVELAND, O.

—Brick-pavement filler .....(n) *130
—Brooklyn-Brighton viaduct. Baker.....*439
—Cleveland Ry. Co.—Granite-block measurement 1094, Yard crane *1124
—Dock wall construction. Carey.....*814
—Engineering forces reorganized.....(n) 868
—Freight terminal, C. & Y.....(n) 45
—Garbage reduction profits; grease 523, (n) 534
—Reservoir excavation, Baldwin.....*838
—Sandblasting a monument .....(n) *82
—Sewage treatment, Activated-sludge. Pratt *671, Hammond.....*798, 809, 911
—Sewer trenching, Steam shovel with grab bucket in .....(n) *1095
—Water-wks. laborers' strike.....(n) 773
Clevens, D. P. Laws of sound..... 817
Clinometer, Special Abney-Bonner *25, 37
Club-house management by engineers...(n) 1206
Coal, Alaska, fields open.....(n) 1109
Coal crusher and sampler, Sturtevant Mill Co.'s .....(n) 824
Coal cylinders, Concrete, built with moving forms, Perry plant, N. Y. Higgins *420, Credit for design 702, Handling retail trade. Higgins *736
Coal, Locomotive, measuring loader, Roberts & Schaefer "Rands" *1083
Coal mine. See also "Mine."
Coal miners' strike threatened.....(n) 437
Coal mines, Rock-dust spreading machines for .....(n) 1116
Coal pier, P. R. R., Balto. *399
Coal, Powdered, as loco. fuel.....1248
Coal production, Anthracite.....(n) 271
Coal-shipping station, E. St. Louis; dump car *416
Coaling pier, B. & O., Balto.; belt conveyors *650, Thawing shed .....(n) 39

COAST EROSION AND PROTECTION

See also "Flood," "Rivers," "Levee."
—Air, Compressed, Calming rough water with, Brashear system *1166

Page

COAST EROSION AND PROTECTION—Continued
—Galveston storm repairs. Blackburn *393, (n) *568
—Long Branch concrete sheet-pile groin. Seaman *650
—Mattress, Tests of backing for flexible concrete river. Okazaki *1080
—Missouri Riv. dike and mattress, Santa Fe Ry. *638, 665
—Revere Beach, Mass., paving.....*456
—Sea-wall mortar joints, Protecting.....(n) 130
Coast Survey. See "U. S.," "Surveys."
Coffer-dam blown up to complete Troy lock and dam *42
Coffer-dam, Siphon to flood.....(n) *856
"Cohesive power of public plunder".....1098
Coke concrete strong after seven years. Heron 850
Collins, A. W. Lining ditches with cement gun 950
Columbia Univ. See "Engineering Schools."
Columbia Riv. highway, Ore. *49, Bridge approach *145, Tunnel *446
Columbus, O.—Flood protection 490, Flood 715, Recovery of spent lime at water-wks. Hoover 1151
Column forms, Pressure of wet concrete on sides of—Univ. of Ill. tests. McDaniel, Garver *933
Column tests, A. S. C. E.....183, *190
Columns, Built-up timber, Tests on. Dewell *324
Columns, Heavy steel bridge, Ill. Cent. track elevation, Chic. *654
Commercial museum, Calcutta.....(n) 1000
Commission. See also "City manager," "Transit," "Public service" and cross references.
Commission govt. abandoned, Denver....(n) 1158
Communities, Engineering for — Conference at Univ. of Ill.....1252

COMPENSATION, ENGINEERS'

—Iowa Eng. Soc. views.....437, 453
—Missouri county engineer, $300 per year... 619
—Montreal Polytechnique Alumni fix fees for engineering service 1183
—N. Y. State positions standardized..... 654
—Okla. State Engineer's salary..... 389
—Thirty-three years of life of successful engineer—Chart *500
Compensation, Workmen's—Typhoid an accident under Wis. law..... 426
Competition. See also "Engineering competitions."
Competition by technical schools—Thesis work, Ohio State Univ. 51, Municipal advice, Minn. Univ. (n) 390, Student engineers offered to Ky. cities 1052, Solomon 1056
Competition by Fed. Public Health Service, Lexington, Ky., sewers 1052, Potter, Blue 1056
Competition, Unethical, for engineering work. Dabney 1245
Computer, Ross "Rapid" circular.....(n) *1016
Computer, Slide rule replaced by new. Yu Wang *1120
Computing devices. See also "Instruments," "Chart," "Diagram," "Table," etc.
Comstock, A. E. Concreting subway.....*496
Concordia, Kan.—Roots in sewer.....(n) *424

CONCRETE

See also "Cement," "Pavements," "Streets," "Roads," "Piles" and special topics generally.
—Aggregate measurement in revolving boxes, Coronet Phosphate Co. Andrews.....*996
—Aggregate, Trap vs. slag for—Columbia Univ. tests for Natl. Slag Co..... 276
—American Concrete Inst. 234, (n) 143, Convention—Reports; Goldbeck and Smith on slab tests; flow under early loads; sand tests; design and construction; flat-slab floors, etc. 379, 386, Subway concreting *496, (ns) 568, 807
—Am. Ry. Eng. Asso. report—Rerolled-rail bars, surface finish, etc..... 626
—Arcade, N. Y., curb and pavement. Doyle..*459
—Arch, Pitt River 242-ft. concrete, Baird, Calif. *1209, Difficult falsework erection. *50
—Beams, Heavy hooped-concrete, used in rebuilding theater, Wilmington. Smith *834, 857
—Beams, Spacing shear steel in.; table. Beard *996
—Bridge abutments, Mich. standard; perspective drawings. Dewart.....*738, 809
—Bridge, Elaborate concrete, for Phila. park *1248
—Bridge materials, Dayton 375, Bids..629, 715
—Bridge, Ornamental, Q St., Wash...*1, 36, 285
—Bridge patent, Thacher, upheld..290, 580, 1157
—Bridge piers of cement and sand in bags, Sumatra *1191
—Bridge-railing expansion bearing, St. Louis *1046
—Bridge—Susquehanna concrete viaduct, Harrisburg, built in halves; blowing plant; collapsible steel arch centers, etc. *537, (n) 670
—Bridges, Ill. Cent. track-elevation, Chicago; slabs, etc. *800
—Bridges, Iowa highway, with I-beams and concrete deck *1183
—Bridges, Ohio highway concrete, Railings for *855, Flat-slab standards.....*947
—Bridges over Mo. Pac. cut, St. Louis. Martin *408

Page

CONCRETE—Continued
—Brooklyn-Brighton viaduct, Cleveland. Baker *489
—Building system, Peltzer's new..... 880
—Caisson pump pit, San Antonio.....*1127
—Canals, Machines for concrete lining irrigation—Umatilla Project. Davis *264, Rio Grande Project *708
—Cement gun, Coating steel at Grand Cent. Terminal with. Jordan *1008
—Cement, How to store. Baird.....1046
—Ches. & O. Nor.—Culvert foundations *128, Sciotoville bridge piers *418, Top forms in arch concreting. Watters.....(n) 34
—Chi. Portland Cement Asso.'s concrete-engineering course .....(n) 1062
—Chi. sewer-work plant *214
—Chi. water tunnel—Concrete lining; traveling conveyor to pneumatic mixer; concreting machine *969
—Chuting, Is it dangerous? 234, Tests 802, "Spouting" or "chuting"? Spouter....1100
—Coal cylinders, Concrete, built with moving forms, Perry plant, N. Y. Higgins *420, *736, Credit for design..... 702
—Coke concrete strong after 7 years, Segundo, Colo. Heron 850
—Column forms, Pressure of wet concrete on sides of—Univ. of Ill. tests. McDaniel, Garver *933
—Cost estimates, Engineers..234, 235, 476, 621
—Culvert forms, Blaw steel.....(n) *536
—Dallas sewage-works construction.....*708
—Dam No. 39, Ohio River, floating concrete plant. Todd *661
—Dam, Plattsburg reservoir. Langlois *106, Dam goes out.....*1106, 1146
—Dams, Inverted-arch. Ellington..... 738
—"Dapple" finish, Panama dry dock. Rousseau 277
—Ditches, Lining Hawaiian, with cement gun 950
—Drier, Portable sand and stone, Rapid Mixer Co.'s .....(n) *824
—Electrical conduits in concrete, Outlet boxes for. Graham 332
—Elephant Butte dam—Cement gun work.... 469
—Engineers experienced in concrete—Names wanted by Portland Cement Asso. McCullough 1199
—Field Museum, Chi.—Concrete spouting plant *31
—Flat-slab floor systems, Pittsburgh ruling on; stress comparisons with Chicago method. Ferguson 910, 1244, Godfrey..1244
—Flat-slab floors, What load to spandrel beams in. Lord.....1245
—Floor, Placing registers in. Hewitt.....*375
—Floors, Extensometer tests of Turner "Mushroom," Condron "Akme" and ordinary girder, beam and slab. Fuller, Moore and Hooker, Seattle 992, 1002, Powell 1197, Godfrey, Ferguson.....1244
—Footing blocks, Sheeting-brace.....(n) 855
—Form wire-tie clamps—American (n) *632, Universal .....(n) *824
—Formwork, Specify amount of. Baird.... 613
—Foundation, Large concrete-mat, Minneapolis building 1095
—Frozen concrete—Building collapse. Rockford .....(n) 294
—Halifax ocean terminal concreting plant—Making and handling large concrete blocks; use of Blaw steel forms (with inset illustration sheet).....*249, (n) 1062
—Hibbing water-wks. winter construction. McDonnell *688
—Lighthouse, Building Brandywine Shoal concrete; concrete caisson. Rout.....*928
—Lime, Hydrated, Tests of effect of—Ashton's report at Concrete Road Conference 470
—Los Angeles—Poor subaqueous concrete. Stewart 30
—Luten patents, etc., on reinforced concrete discussed. Royse 185
—Mattress, Tests of backing for flexible concrete, Japan. Okazaki.....*1080
—Mixer, Barrel, with hoist.....(n) 96
—Mixer, Small, with silo hoist, Chain Belt Co.'s "Rex 6".....(n) 920
—Mixer, Trolley-car, Birmingham, Ala.....*276
—Mixers, Largest, Smith's, Aluminum Co.'s dam, Whitney, N. C.....*676
—N. Y. subway—Pneumatic mixing and placing of concrete. Comstock *496, Old concrete found good. Ridgway (n) 568, Relative value of central mixing plants. Ridgway .....(n) 807
—Nickel Plate freight house, Hammond, Ind. Concrete plant handled on four freight cars *1238
—Panama buildings—Hollow blocks.....(n) 270
—Patents on reinforced concrete, Defense of suits on 331, *813
—Piers, Ocean Park, Calif., stand fire...(n) 1157
—Piles, Concreting, with tremie, Cincinnati viaduct. Maxwell 614
—Pipe, Making, Dallas, Tex.; Lock Joint Pipe Co.'s bottom-dumping bucket.....*563
—Pipe, Tar coating, Arrowdock diam. Paul.. 62
—Pipe transportation by rolling.....(n) *952
—Poles poured in place, Barge Canal...160, *162
—Railway roadbed, Concreting soft spots in Queen & Crescent 685
—Railway trestles, Kan. Cy. So.....*203

Page

CONCRETE—Continued
—Reinforced-concrete beams, Bending moment in; economy of continuity. Roark *354, *790
—Reinforcement dispute—Should engineering societies pass on public questions? Duffield 818, Porter 1148
—Reinforcing rods, Stripped, as proof of green concrete 668
—Reservoir, Covered, Hibbing, Minn. McDonald *688, *990
—Reservoir, Lining Hill View, with concrete and riprap *1022
—Retaining wall, Box concrete, on Western Pac. Knowles *633
—Retaining wall built by large steel traveler, Magnolia cutoff.....*1218
—Retaining-wall design. Fish.....*268
—Retaining-wall patent, Bone's, and its anticipations *254, 281, 331, 338, (ns) 246, 868, Bonehead 429, Walker 432, Speers 478, Frankland 524, Early history, E. P. Bone 573, Old chimney with cantilever base. Wise *572, Dock walls. Carey *814
—River wall, Cedar Rapids.....*588
—Roof slab, Memphis—Frozen concrete and poor design cause failure..... 579
—Sewer failure, Cairo, Ill.....*505
—Sewers, Austin, Tex.—Steel scarcity results in plain concrete *903, Bedding cement pipe sewers in lean concrete..... 996
—Slabs used at D., L. & W. crossing, South Orange 521, *526
—Stadium, Wash., D. C., high school.....*138
—Stairway for hillside footway, Passaic, N. J. Odell *1128
—Step and stair form, Park adjustable (n) *248
—Tank water-tight, Integral steel plate to make. Ambursen *1103
—Tank, Waterproofing concrete, with cement gun. Ambursen *1044
—Tanks 11 years old on southern railroads *1027
—Test at Sheffield Sci. School with various aggregates and sands—Strength not result of aggregate strength. Hendrick....*444
—Testing concrete in roads, U. S. Dept. Ag. .....(n) 27
—Testing, Exhibition, at Cement Show, Chicago. Thomas 695
—Testing floor slabs using spring scale.....*126
—Tests of concrete distributed by short chute, by comm. for Natl. Conference on Concrete Road Bldg. 802, Spouter.....1100
—Tile adhesion to concrete backing—Bost. & Albany test, Worcester.....*1191
—Train for concreting retaining wall, Bingham & Garfield Ry., Utah.....(n) *1192
—Trains, Small dump-cars on concreting, track-elevation work, Rock Island's, at Chicago *1188
—Tremie plant for concreting subaqueous pedestals, Naval Training Station, Newport. Smith *1186
—Trestle, Concrete highway, across Yolo Bypass, Sacramento *358, Reinforced concrete on unit system 377, Experiences and costs in making the units. Holmes *825, Concrete piles; driving them *358, *854, Weir 1204
—Trim-estimating tables. Corbett.....(n) 34
—Tunnel lining, Boston subway.....*136
—U. S. Bureau of Standards' report—"Strength and Other Properties of Concrete as Affected by Materials and Methods of Preparation".....1053, 1058
—Viaduct, Concrete, vs. fill for street elevation, Astoria, Ore.....*1176
—Viaduct, Jefferson Ave., St. Louis, with special expansion provisions—Split piers. Martin *1078
—Viaduct, Park Ave. concrete, Cincinnati; concreting arches, etc. Ruth.....*659, *936
—Viaduct, Denver street.....*166
—Washer, Portable, for aggregate, Stocker..*818
—Water-conduit break, Victoria.....571, (n) 580
—Water-meter boxes, Dallas.....*614
—Waterproofing membrane intact after extreme expansion, Long Isl. R. R. retaining wall *803
—Wis. Riv. power house and dam on sand foundation *1113, *1211
—Zinc sulphate under paint..... 443
Condron "Akme" and other floors tested 992, 1002, 1197, 1244
Conductor heads for roof drainage. Wolf *901
Congress. See "Laws," "U. S.," etc.
Conkling, C. C., Death of..... 965
Connecticut gravel roads, Calcium chloride for. Bennett 87
Connell, W. H. Snow removal, Phila.....*221
Conner, C. N. Horizontal resistance of piles under retaining walls 524
Conservation, Okla. nat. gas..... 149
Conservation, Water-power 569, 906, (ns) 294, 1205, 1254
Constant-level orifice box for feeding chemicals. Gavett *785, Brewer *1055
Construction camp. See "Camp."
Construction engineers' diary. Fish.....*110, 135
Construction plant, Home-made, that helped build the Kensico dam. Smith....*326, (n) *82

CONTRACTS AND CONTRACTORS

See also "Construction," "Camp," "Cost."
—Atlanta garbage-incinerator case (ns) 869, 1109
—Ballasting track by contract, Mo. Pac....*828